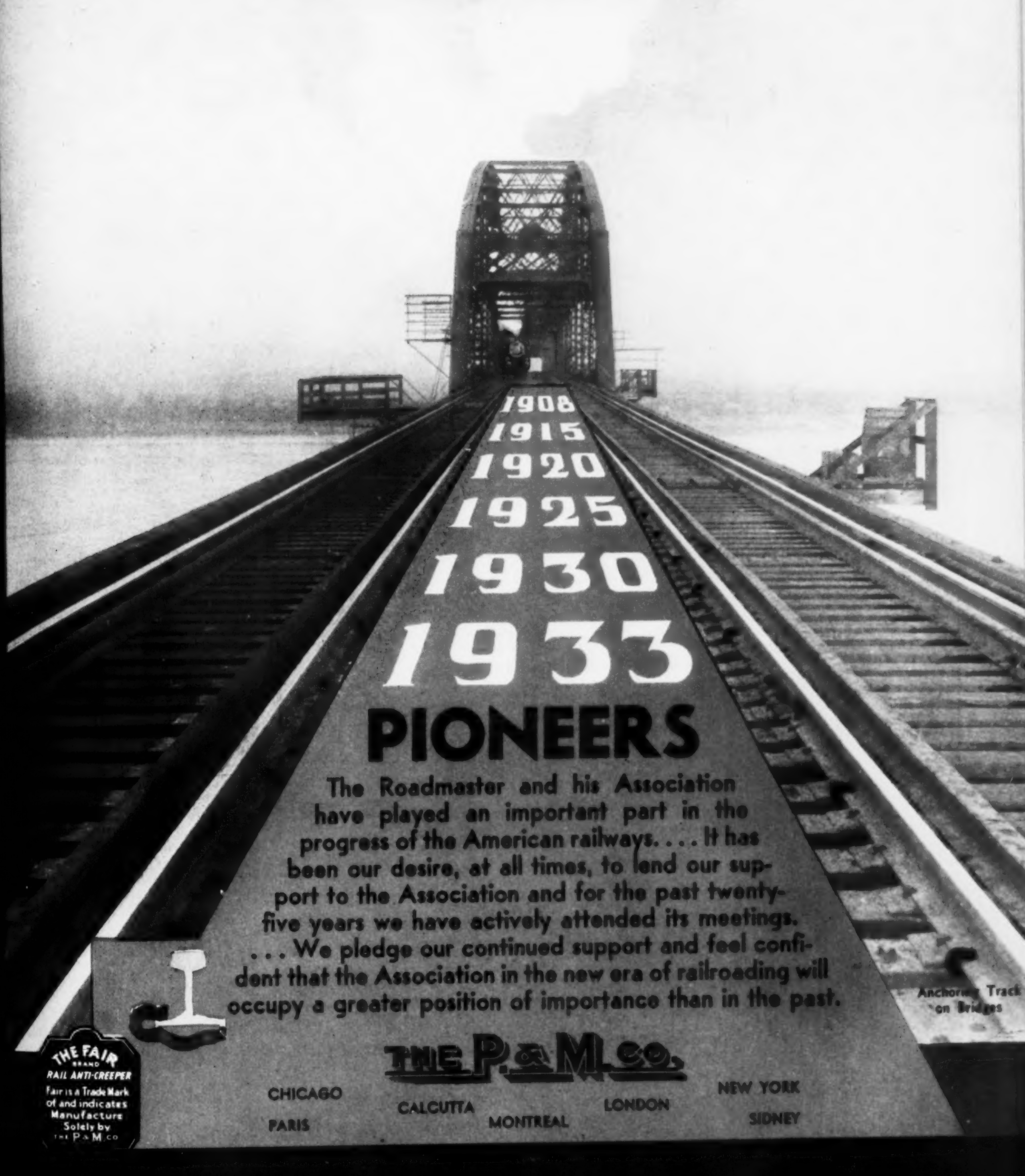
ROADMASTERS' CONVENTION IN PRINT NUMBER

October, 1933

Railway Engineering and Maintenance



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NEW HEAT-TREATED RAIL CROSSINGS SHOW SUPERIOR WEAR RESISTANCE IN 2-YEAR TEST ON BOSTON AND MAINE

Careful Check-up of Installation at North Station, Boston, reveals points only slightly worn after long service

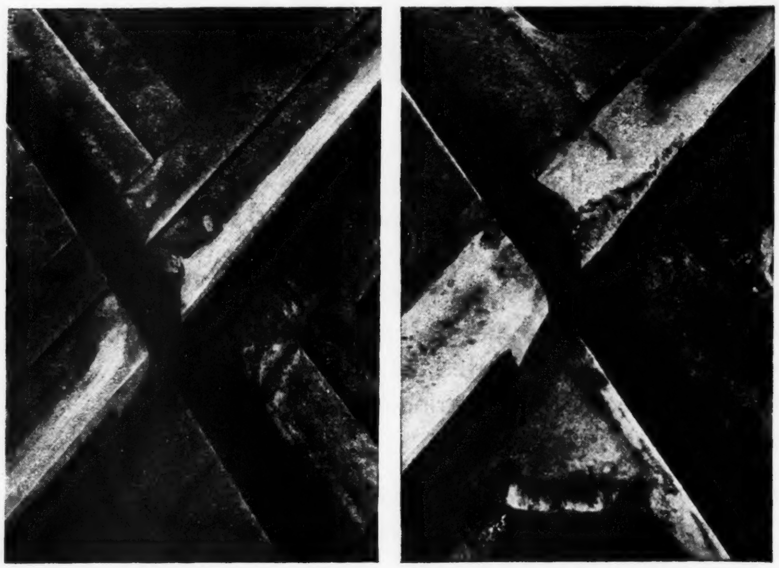
MAKE FAR BETTER SHOWING THAN SOLID MANGANESE

After two years of service at a busy terminal, a group of Bethlehem Heat-Treated Rail Crossings have shown about one-half as much wear as a group of solid manganese crossings, under identical conditions.

These Bethlehem Heat-Treated Rail Crossings were installed as part of the redesigned track layout at the North Station of the Boston and Maine Railroad, at Boston. For the sake of comparison they were paired with solid manganese crossings.

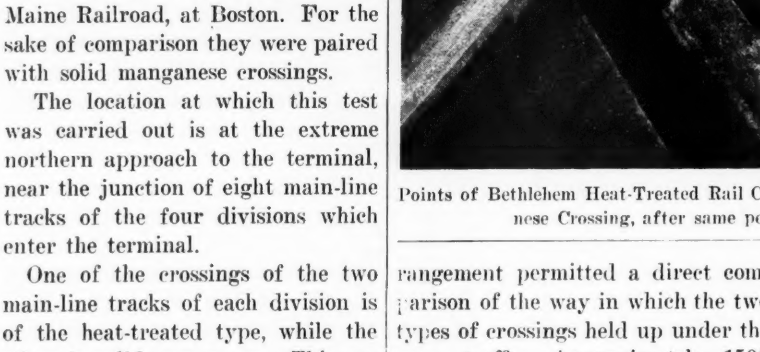
The location at which this test was carried out is at the extreme northern approach to the terminal, near the junction of eight main-line tracks of the four divisions which enter the terminal.

COMPARE THESE POINTS!



Points of Bethlehem Heat-Treated Rail Crossing and, at right, points of Solid Manganese Crossing, after same period of service at same location.

One of the crossings of the two main-line tracks of each division is of the heat-treated type, while the other is solid manganese. This arrangement permitted a direct comparison of the way in which the two types of crossings held up under the same traffic. Approximately 1500 train and engine movements pass over the crossings at this location every 24 hours.



Arrangement of foundation slabs under crossings.

Now, two years after installation, careful measurements have revealed the superior ability of the heat-treated crossings to stand up under heavy traffic. They have shown virtually twice the wear resistance of the solid manganese crossings in service at the same location over the same period.

Foundation Construction

To heighten the value of the comparision as regards resistance to wear and batter, an entirely new foundation was provided for the installation of these crossings.

This foundation, constructed in accordance with A. R. E. A. recommenda-

Bethlehem Heat-Treated Rail Crossings paired with solid manganese crossings for comparison of wearing qualities, in main-line tracks of Boston and Maine Railroad.

tions, is entirely sub-drained. It consists of a series of 15-inch reinforced concrete slabs laid side by side and supported by 4 inches of cinders. The crossings were laid on treated ties, placed diagonally, and supported by 10 inches of crushed stone.

Better Physicals

The following comparison shows the increased tensile strength, higher Brinell hardness and other improvements in physical properties that the special heat-treatment used in the manufacture of Bethlehem Heat-Treated Crossings imparts to the standard-analysis carbon steel rails:

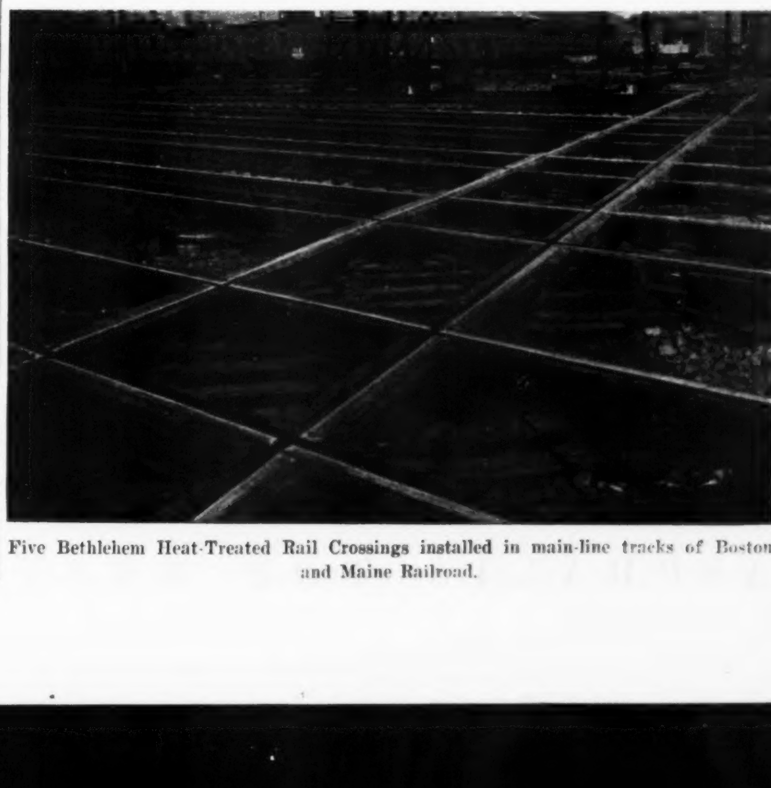
	Standard Rail	*Bethlehem Heat-Treated Rail*
Elastic Limit	83,000 lbs.	126,700 lbs.
Tensile Strength	137,800 lbs.	177,400 lbs.
Elongation	8.8%	7.7%
Reduction of Area	12.1%	11.7%
Brinell Hardness	282	361
Izod Impact	1 ft. lb.	7 ft. lbs.

Made by Special Process

Bethlehem Heat-Treated Rail Crossings are made by a special process which imparts higher tensile strength and greater Brinell hardness to the standard carbon-steel rails. Further, the use of rolled and forged parts gives these crossings a high degree of resiliency, resulting in remarkable ability to withstand heavy wheel impacts.

These new crossings are not only longer-lasting and smoother-riding than any other type, but they require less maintenance. Experienced maintenance-of-way engineers who have seen how Bethlehem Heat-Treated Rail Crossings stand up under high-speed, main-line traffic, and know the dollars that they save, foresee their extensive adoption.

BETHLEHEM STEEL COMPANY



Five Bethlehem Heat-Treated Rail Crossings installed in main-line tracks of Boston and Maine Railroad.

TWENTY YEARS PROGRESS

Through Oxweld Research and Development

•

Twenty years ago the oxy-acetylene process of welding and cutting metals was practically unknown on the railroads. Such apparatus as was in existence was of crude and cumbersome design. Problems of oxygen and acetylene production and distribution on a broad and economical basis were unsolved. Special welding rods for specific applications were unknown. Effective procedures in the application of the art of oxy-acetylene welding and cutting were non-existent.

The Oxweld Railroad Service Company pioneered the introduction and development of the autogenous welding and cutting processes on the railroads and during two decades has cooperated with the carriers in working out the innumerable problems the successful solution of which has led to substantial reduction in the cost of maintaining equipment and roadway.

As a result of intensive and continuous research the railroads are at present effecting economies running into millions of dollars a year through repair and reclamation of locomotive and car parts, through the extension of rail life by the building up of wear and batter and through the use of the highly efficient oxy-acetylene cutting procedure in the manufacture of new parts, in the stripping of equipment for repairs and in the demolition of obsolete locomotives and cars.

The evolution from the embryo state of twenty years ago to the present high stage of development has resulted from the combined efforts of The Oxweld Railroad Service Company and affiliated Units of Union Carbide and Carbon Corporation.

The Linde Air Products Company, the World's largest producer of oxygen and The Prest-O-Lite Company, Inc. have worked out the problems of gas production and distribution.

Oxweld Acetylene Company, the World's largest manufacturer of oxy-acetylene equipment and supplies has solved the intricate problems of apparatus design.

Union Carbide and Carbon Research Laboratories, Inc. have developed the special rods best fitted for specific applications and have also contributed to the development and standardization of the most efficient welding and cutting procedures.

The Oxweld Railroad Service Company, through its service arrangement, whereby engineers and welding experts work with the railroad organizations in the introduction and perfection of welding and cutting procedures, has placed at the disposal of the railroads the facilities and experience of this great organization devoted to the development of the art of oxy-acetylene welding and cutting.

OXWELD RAILROAD SERVICE

THE OXWELD RAILROAD SERVICE COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

NEW YORK, Carbide and Carbon Building
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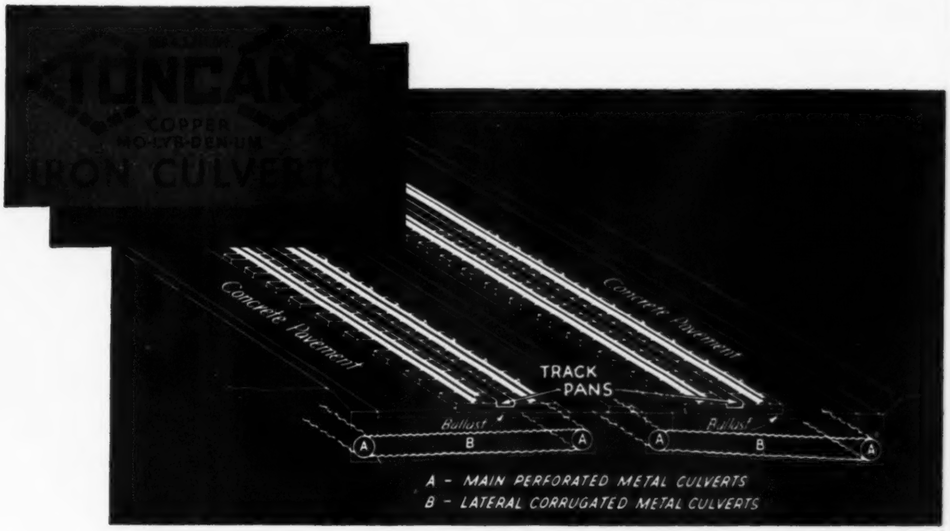
for EFFICIENT DRAINAGE *along track pans*



Nowhere along the roadbed is efficient drainage of more importance than where track pans permit trains to take water on the fly. The track must be kept in perfect alignment and at perfect grade to protect the pans and to insure proper clearance between the pans and the scoop.

This condition can be maintained only if adequate drains are provided to carry away quickly the quantities of water splashed to each side. Roadbed and ballast must slope away from the pans. At the ends of the ties between the tracks, Toncan Iron Perforated Culverts should be laid about two feet below the ballast. At the ends of the ties on the outside, a concrete pavement should be laid to carry the water to similar culverts laid in the outside ditch line, somewhat deeper than the inside culverts. Laterals of plain Toncan Iron Culverts connect the inside and outside drains. Backfilling should be crushed stone, gravel or slag.

Toncan Iron Culverts should be specified in the interest of economy—because every test shows that this alloy of refined iron, copper and molybdenum lasts longer in service.

Write for your copy of the "Toncan Culvert Handbook."

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No. 58 of a series

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Subject: Working With Associations

September 28, 1933

Dear Reader:

As you will note we are giving special attention in this issue to the work of the Roadmasters and Maintenance of Way Association. In fact, through the expedient of a "Roadmasters Convention in Print" issue, we are making available for the members of this organization and for you the valuable information included in reports which might otherwise have remained unavailable for another year. By this measure, we feel that we have developed another opportunity to serve you.

Incidentally, this action illustrates the very close mutual interest that we feel that we have with such organizations as the Roadmasters Association, the American Railway Engineering Association, the American Railway Bridge and Building Association, the American Wood-Preservers' Association, etc. These organizations provide agencies through which railway men can co-operate in the investigation of problems and exchange experiences looking to their common solution. Their work is voluntary and without direct monetary reward. It is primarily a co-operative service for the betterment of their industry.

So it is with a magazine such as Railway Engineering and Maintenance. Like the associations, our function, as we visualize it, is to promote the most efficient practices. To do this, we are constantly searching for and describing such improvements as we find on one road or another. We try to present these descriptions in a way that is interesting to you, but, of far greater importance, we endeavor, through this information, to bring to your aid, ideas that will help each reader to bring his performance to the level of the best.

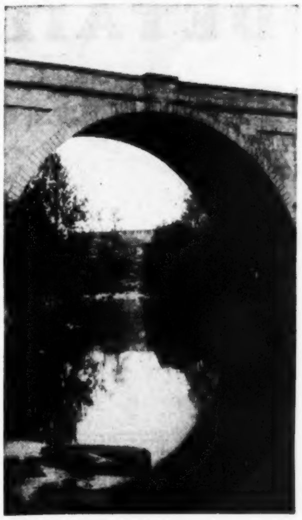
In keeping with this objective, we endeavor to encourage constructive association work and to give the widest possible publicity to the findings developed through this agency. Members of our staff give freely of their time to the work of these organizations, frequently at considerable personal sacrifice, because they believe that such work is of great benefit to the railway industry.

We believe sincerely in the old adage that "he profits most who serves best." Are we right?

Yours sincerely,

Elmer T. Howson

ETH*JC Editor



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Railway Engineering and Maintenance

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OCTOBER, 1933

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Railway Engineering and Maintenance

WORK EQUIPMENT

Its Use in Time of Unemployment

IS THE use of so-called labor-saving equipment contrary to public interest, or, in other words, is it unpatriotic in these days of such widespread unemployment? Should the equipment now on hand be laid aside and should further purchase be discountenanced while we return, so far as possible, to hand methods as a means of providing more men with gainful employment? These questions are in the minds of not a few railway officers today. They are especially before officers of the engineering and maintenance of way department where mechanical equipment has received such wide acceptance in recent years.

That the present widespread unemployment constitutes the most pressing problem before the country today is universally recognized. Authoritative estimates place the total number of persons still unemployed at eight to ten million, after making due allowance for the possible two and one-half million re-employed since spring. Such a condition requires correction.

What Is Labor-Saving Equipment?

The national administration recognizes this situation as the most pressing confronting it and it has launched a number of measures that are designed to alleviate conditions, most prominent among which are the public works program and the extension-of-employment features of the N.R.A. codes. In the face of such heroic measures to increase employment, it is not surprising that questions should be raised regarding the propriety, at this time, of using equipment that will increase the output per man and reduce the number of men required to complete a specific task. To be specific, is it proper for maintenance officers to use such equipment as tie tampers, weed burners, snow melters, concrete mixers or even motor cars today? The crisis through which we are passing is so serious that it is of the greatest importance that a question such as this be answered correctly. This is no time for false thinking; neither is it a time for hysteria. Let us study the facts.

In the first place, it is necessary to define what equipment is included in the labor-saving classification. Obviously, the many mechanical aids that have been introduced in maintenance work in recent years come within this category. But is one also to include such equipment as the steam shovel and the pile driver which have been used for a generation and more? Or the air hoist and the hand car of a still earlier day? Taken literally, the greatest employment would be provided by going back to the hand shovel, the wheelbarrow and the grampus. Such an extreme position is, of course, unreasonable, but it illustrates that the question is one of degree, as well as of principle.

Does Equipment Reduce Employment?

In studying this problem, it is essential to determine whether the use of labor-saving equipment actually reduces the amount of labor employed. At first glance, this is, of course, the result, for if consideration is given only to a specific task, the purpose for using mechanical equipment is to reduce the cost of the work and this reduction in cost is effected by decreasing the amount of labor required. But this is only part of the story. The amount of maintenance work which the railways do today is not determined by the volume which needs to be done but by the amount of money which is available. Therefore, any money that is saved by performing the first task with the maximum efficiency is available for other needed work and it is so expended, providing employment here in a task that it would otherwise be impossible to undertake for lack of money. The result of the use of the most efficient methods today is measured therefore by the completion of a greater amount of sorely-needed work, rather than by a decrease in actual employment.

Unemployment in Industry

There is also another phase of this problem of the use of work equipment that is equally pertinent, even though less directly applicable to the railways. This relates to the labor employed in the construction of this equipment. Industry is divided roughly between (1) consumer goods industries, or those which produce goods for immediate consumption, as, for illustration, food and clothing, and (2) capital goods industries, which make the machinery and equipment used in the production of consumer goods. Comparing these two groups of industries, statistics show that between 1929 and 1932, the decline in employment in the consumer goods industries approximated 24.5 per cent, while the decline in the capital goods industries was 60 per cent. In other words, it is in these latter concerns, which produce such machinery as that used in maintenance of way operations, that the decline in employment has been greatest. Obviously, any measures which retard or discourage the use of such equipment add still further to the unemployment in these industries and remove the persons so laid off from the market for consumer industries products. This is a phase of the use of labor saving equipment which has, therefore, a very

direct bearing on our national employment problem. It is one to which the President and his advisers are now greatly concerned over and to which they are now giving special attention, as evidenced by the efforts which they are making to induce the railways to purchase rails, etc.

Is Efficiency to be Disregarded?

There is still another consideration that, so far as the railways are concerned, is of very direct concern. This is the present necessity, as well as the general obligation, to direct all their activities with the maximum efficiency and economy. By reason of the marked decline in traffic and in earnings, the roads have been forced to curtail maintenance of way expenditures drastically. This, as pointed out in the last issue, has caused them to lay off more than 200,000 men in this one branch of railway service alone. The result is that there is today a vast accumulation of work, estimated to exceed $800,000,000, that is pressing for attention. Yet, in spite of such drastic retrenchment, the roads of the United States, as a whole, failed to earn their fixed charges in 1932 by $153,-308,487 and in the first six months of this year they fell short of earning these charges by $101,710,247.

No industry can long continue such a record and survive. It is evident that the roads must perform every operation with the maximum economy in order that as much as possible of the pressing work may be done with the funds that are available. To do otherwise is to invite disaster for the railway industry itself and to add still further to the troubles of industry at large.

What Is Government's Attitude?

Is such a policy in conflict with that of the government itself? This can be answered in several ways. In the first place, nowhere has the government requested or encouraged industry to replace efficient methods with those of lesser efficiency. Neither has the N.R.A. formulated any such policy, nor is it contemplating any such action. Likewise, in the expenditure of government funds for public works, federal authorities have neither advocated nor countenanced needlessly costly methods of doing work, but are exerting every effort to insure that the money allocated for public works is expended most efficiently, in order that it may go the furthest and in this way yield the greatest total amount of employment and the maximum public benefit.

Likewise, as to railway administration, the government is now represented through the federal co-ordinator of transportation, Joseph B. Eastman, who has urged the roads, on several occasions, to increase employment through undertaking larger programs of roadway and equipment maintenance. In no instance, however, has he suggested other than the most efficient methods, while it is known, on the contrary, that on several occasions where he has been urged to discourage the use of labor-saving equipment, he has refused to accede to these requests. Rather, his attitude has been, like that of the federal public works department, that the present demands the elimination of all possible waste in every branch of railway activity.

There is, therefore, no basis, in economics or in the attitude of the federal administration, for the replacement of mechanical aids with hand labor. On the contrary, there is much to support the contention that such a step, if carried to any length, would go far to defeat the very object for which it was advanced, for the disturbance to an already disorganized industrial setup would be such as to lead to still further unemployment. Rather, the constructive attitude for maintenance of way officers to take in this matter is to conduct their varied tasks with the greatest possible efficiency, using mechanical aids as heretofore wherever they will contribute to this end, and thereby make possible the performing of the largest possible amount of work with the funds available, looking to the increased amount of work thus done to provide the added employment that is so greatly to be desired.

WATER POCKETS

Few Problems Have Been More Baffling

FEW of the problems that have been put up to maintenance engineers have been as baffling as those of soft spots and water pockets in the roadbed. Few of them have persisted so long without being brought nearer to solution. Although these defects appeared during the earliest days of railroading, and while it was understood in a general way that lack of or inferior drainage was primarily to blame, little was done to correct the trouble.

Early maintenance and other engineering literature contain many references to the benefits that accrue to the roadbed as a result of adequate subsurface drainage. There are many equally significant references that indicate failure to take the measures necessary to provide such drainage.

For many years water pockets had given trouble to an extent that maintenance officers themselves had generally failed to appreciate. For this reason, about 25 years ago, when cars and locomotives began to increase in size and weight more rapidly than before, and when the trouble became more aggravated and soft spots began to appear in new places, many of these officers were under the impression that a new type of affliction had made its appearance. Great interest was aroused as to both the cause and the remedy. Investigation proved, however, that the railways were not confronted with a new problem but with an extension of an ancient one.

Since that time the matter has been given more serious study, out of which several definite facts have been established. The first and most obvious of these is that water pockets result from the entrapment of water in depressions in the roadbed, which depressions may be formed by the settlement of ballast into the subgrade, by boxing the ballast or they may be inherited from the construction period. Frequently, they are formed by the cavities left through the decay of timber remaining in the embankment from construction or other trestles. Once formed, a water pocket may extend itself indefinitely unless corrective measures are undertaken.

Another fact of importance is that water pockets enlarge only through plastic flow of the soil. Considering the materials commonly used in roadbed construction, it is correct to say that only when moisture is present in quantity does the soil become sufficiently plastic to flow

under the loads imposed by the combined weight of the roadbed and traffic. While considerable collateral information has been developed, these primary facts suggest the remedy, which can be summed up in one word—drainage.

Water pockets never form in a dry roadbed. Drainage which cuts off all lateral flow of water toward the subgrade and at the same time lowers the ground-water level under the roadbed to the point where capillary attraction becomes ineffective, will assure conditions that are most unfavorable to the formation of water pockets. Should they form, however, the necessity for drainage becomes still more pressing. In this case, the plan for drainage must provide for removing quickly all water that has collected in or later reaches the depression in which the water is entrapped. To accomplish this, two fundamental requirements must be met: The drains must have large capacity and they must be well below the lowest point of the reservoir.

These things sound simple and in principle they are. It will often be found in practice, however, that unless all of the details surrounding the trouble are given consideration, the remedial measures will be only partially successful. These include neglect to study the soil, its action under the conditions to which it is being subjected and, so far as they can be determined, the effect of the proposed relief measures. So important are these matters from the standpoint of cost as well as of physical improvement, that no one can afford to neglect to make the most exhaustive investigation of every case in which it is proposed to eliminate soft spots and water pockets.

SAFETY

No Duty is More Important than Accident Prevention

THE last three years have been especially favorable for the attainment of improved records in accident prevention. Gangs have been smaller, traffic has been less, and the average service age of the men has probably been higher than at any previous time in railway history. The hazard of the experienced employee has ceased to be a factor. But this state of affairs does not justify an attitude of complaisancy or warrant any departure from a strict enforcement of established rules of safe practice in all lines of work, for "no-accident" records are all too easily broken.

The enforcement of safety rules has a double effect. It prevents accidents directly because each rule is a safeguard against a particular type of accident as has been learned through some painful or fatal experience. However, of equal effect is the indirect result that is gained by keeping the men "safety conscious." In the earlier days of the Safety First movement and at times when the forces included large numbers of inexperienced men, safety meetings, conversations or examinations were needed for the most part to teach safety rules. Today the problem is more largely that of seeing to it that men continue to think safety.

Nor is the problem by any means confined to the men in the ranks. All too large a proportion of the accidents, especially motor-car accidents, involve officers, and in these days when safety of tracks and structures is ever uppermost in the minds of officers, they must not lose sight of their own personal safety. Men are much more readily taught by example than by precept.

RAIL BONDS

Maintenance Men May Have Direct Interest

SECTION foremen and supervisors are prone to look upon rail bonds as entirely within the province of the signal department and to consider that the problems of rail bonding do not concern them, except that they must exercise every precaution to avoid breaking or otherwise damaging the bonds after they have been applied. That this attitude is not entirely tenable is apparent when one considers the great number of highway crossings at grade, station and other platforms extending across tracks, paved streets and other similar forms of construction which virtually house many sections of the main tracks.

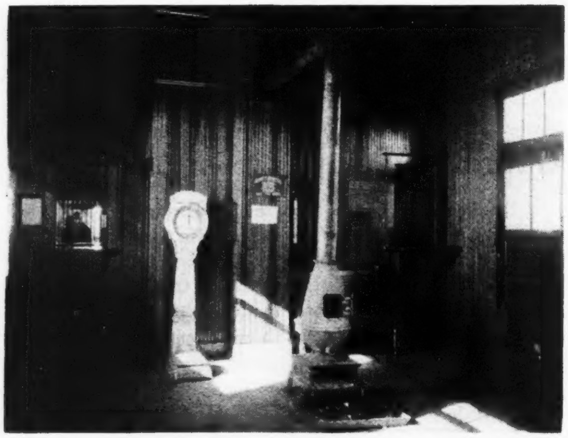
Maintaining rail bonds through wood-plank crossings and platforms is not an easy task, as every maintenance man knows, although wood-plank construction offers the least obstruction against access to the bonds. The situation becomes far more difficult, however, where more permanent types of crossing construction are used of such materials as metal, concrete slabs or monolithic concrete, mastic and paving blocks. It is widely accepted by the maintenance forces that a rail-bond failure in crossings or platforms requires the tearing up of a part of the crossing to give the required access to the joint, often resulting in a loss of materials in addition to a considerable sum represented by non-productive man-hours.

While there are other sufficient reasons for doing so, the rail bonding difficulty is being avoided in part by the growing practice of butt welding to provide continuous rails through crossings and platforms, thus eliminating all joints. Another practice that is gaining ground is the use of welded bonds. Those who are doing this form of bonding through crossings and platforms point out that the bonds can be applied and replaced without disturbing the crossing; that bonds of this type are always open to inspection and that when the cause of intermittent signal trouble is sought, there is no necessity for tearing up a crossing or platform, with the probability that the hidden bonds will be found to be working properly and that it offers greater assurance of protection against those forms of rail failure which occur within the limits of the angle bar and which are relatively more prevalent in crossings, platforms, paved streets and elsewhere where non-rail traffic must be served.

It is apparent that the interest of the maintenance man in rail bonding is not academic but real, particularly as it affects the rail through platforms and paved areas. The question of his own costs, as well as those of the signal department, is involved, together with the depreciation that results from the occasional or frequent removal and replacement of the material housing the rail. His attitude should not, therefore, be one of indifference, but of alert interest.

Solving the Heating Problem for Small Buildings*

A. R. E. A. committee discusses the progress that has been made in recent years and compares the various systems now being used



Caboose Stoves Are Inappropriate When More Efficient Equipment Can be Had at Less Operating Expense

WE ARE sometimes confronted with unusual heating problems for small railway buildings where steam connections cannot be made with central power plants and where, in some cases, the possibility of large fire loss, restricted space, inaccessible location or other conditions make the use of individual coal-fired boilers or furnaces undesirable. In other cases operating conditions may make unusual types of heating apparatus necessary.

Much progress has been made in the last ten years and is still being made in the efficiency and convenience of heating apparatus. Although the cost of fuel is one of the major items of railway operating expense, it should not necessarily be the controlling factor in the selection of small heating plants, for the unit cost is generally low, so that the total fuel cost for small plants may be relatively unimportant as compared with the cost of labor for tending the fire and for maintenance. Furthermore, uniform heat promotes higher efficiency among employees, resulting in fewer layoffs for colds and sickness. In railway stations, the comfort of passengers and shippers will do much to mold favorable public sentiment and create good will.

Many factors should be considered in selecting the types of heating apparatus to be installed, such as:

1. The volume of space to be heated.
2. The kind of fuel that is most easily available.
3. Whether the heater is to be accessible or inaccessible to the public.
4. Whether it is to be fired by the janitor or others.
5. Whether space is available for fuel and ash storage.
6. The unsightly and unsanitary condition produced by stoves.
7. Fire hazard from overheated fire bowls, stove pipes, or chimneys.
8. Whether heat is to be maintained day and night.
9. Whether a uniform temperature throughout the day and night or a quick hot temperature is required.

Heating apparatus for small buildings may be divided into three general classes as follows:

(A) Individually coal-fired stoves or heaters, operated by the occupants of the room in which the heater is located.

(B) Systems heated with furnaces or boilers fired by a janitor or a regular attendant.

(C) Electric, gas or oil-burning heaters regulated automatically without attendant.

*Abstract of a report presented by the Committee on Buildings of the American Railway Engineering Association at the convention at Chicago on March 15. The report is the work of a subcommittee of which Eli Christiansen, assistant engineer of buildings, C. R. I. & P., was chairman.

Notwithstanding the progress made in recent years in the development of heating apparatus, the heater most commonly used in small railway buildings today is the same three-piece cast iron stove that was used 40 years ago. This is due, no doubt, to the low first cost and simple construction of this type, and also to the fact that such equipment does not require skill for either operation or maintenance. Moreover, replacements for this type of heater may be cast in railroad foundries. For switchmen's shanties, hump riders' houses and other places where a quick hot fire is desirable to warm men who are constantly dodging in and out of bitter cold weather, probably no better method has yet been devised than the common stove. However, for the comfort and accommodation of the traveling public, who are accustomed to much different systems at home and in their places of business, such stoves are inappropriate when more efficient equipment can be had at less operating expense.

Where stove heat is desirable, the modern base burner or circulating heater is highly efficient as compared with the older types and requires much less fuel and less frequent attention. These stoves have heavy cast-iron fire pots and the domes are enclosed in an outer casing of steel or enameled iron, so arranged as to draw cold air from the floor at the bottom, and expel warm air through openings at the top, thus maintaining constant circulation of the air in the room. Care should be taken to select stoves of ample size so that it will be necessary to keep the drafts open only in the coldest weather. Although this type of heating system may be installed and operated at a low cost per unit, it has its limitations and when two or more stoves are required for the same building, the operating cost of a furnace or boiler is generally less.

In railway stations the unsightly appearance of stoves is often objectionable. It is difficult to keep coal and ashes off waiting-room floors, especially where it is possible for patrons to open the fire or ash doors; there is also danger of children being burned and of irresponsible persons pulling the fire out onto the floor. In addition there is danger of stove pipes becoming overheated when drafts are opened and neglected, and costly fires are sometimes caused by the bursting of overheated fire bowls.

Warm Air Furnaces

Class B heating systems include warm air furnaces and steam and hot water systems. Warm air furnaces are of two general types, those with a hot air outlet and single recirculating duct, and those with hot air supply and return ducts to the various rooms. The warm air furnace with a single hot-air outlet and return duct is suitable for small buildings that are arranged to permit

free circulation of air from the furnace to all parts. The warm air furnace with hot air supply and return ducts to the various rooms is more expensive than the latter type, but has the advantage that it supplies heat to separated rooms and furnishes a more positive method of control by adjustable registers in each room. Either of these types can be combined with the use of a water jacket and the installation of a small amount of direct radiation in rooms at a remote distance from the furnace, which are the hardest to heat. The construction cost of a hot-air heating system is ordinarily less than for a steam or hot water system, and the hot air furnace lends itself better to the installation of evaporators for increasing the humidity.

In some hot air systems, air is taken from the outside as well as from the inside of the building, providing both heat and ventilation. The greatest disadvantage of these systems is that the circulation depends upon natural draft; i. e., on the difference in weight between the air inside and that outside of the flues, so that the force providing the circulation in the flue is always small, making it difficult to heat rooms at a great distance from the furnace on the windward side of the building, and limiting the horizontal flues to a distance of not to exceed 15 ft. In addition, the method of controlling heat distribution with a warm air system is not as positive as with steam or hot water, and there is an objectionable amount of dust, ashes and gases circulated to the spaces heated. However, one decided advantage over steam systems is that, even though the plant has been banked, there is always some heat being carried to the various rooms during the night, providing for a more gradual drop in temperature than with steam.

In buildings used for offices or where a number of people are employed, proper humidity is an important consideration, as it lowers the temperature at which work may be done in comfort, increases the efficiency of the occupants, and decreases the time lost due to illness. In small buildings, furnaces with certain refinements such as an electric fan for promoting circulation, improved evaporators for controlling humidity, and a combustion chamber so constructed as to reduce the circulation of dirt and gases, promise to become more popular and offer certain advantages in the control of humidity as compared with steam or hot water heating systems having radiators in each room.

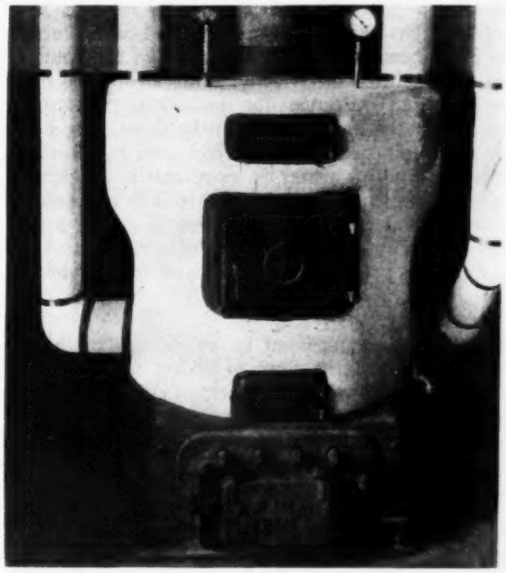
Steam Heating Systems

Steam heating systems have been in use for many years and give very good results. These systems cost more than either stoves or furnaces, but afford a more positive method of heat circulation than either stoves, furnaces or hot water boilers, unless a circulating pump is used in connection with the hot water system, which would not ordinarily be justified in a small building.

From the standpoint of ventilation, direct steam heating without other means of ventilation is not as desirable as a warm air furnace. Mechanically, however, it has many advantages, as the modern radiator is easily adaptable to almost any location in the room and is not easily affected by winds. The circulation is positive and a distant room can be heated as easily as a room close to the boiler. There are several types, such as one-pipe gravity and two-pipe gravity, vacuum-vapor and other combinations, including direct radiation, indirect radiation, etc. Through the use of thermostatically-controlled valves at the radiators, this system can be made to maintain almost any desired room temperature. However, it does not offer as satisfactory a method of controlling the building temperatures at the boiler as the hot water system; although with the use of vapor specialties, the system can be operated at very low pressures and the temperature of rooms can be controlled by valves at each radiator, which regulate the flow of low-pressure steam. Vapor systems make use of steam at pressures slightly higher than atmospheric and in some cases below. A well-designed steam heating system develops from 60 to 70 per cent of the heat in the fuel.

Hot Water Heating Systems

Hot water heating systems are quite similar to steam systems except that the heating medium, being at a lower temperature, requires more radiating surface. There are a number of different types of hot water heating systems, such as the direct hot water, up-feed, one-pipe system; the overhead system; the pressure or closed system; and the open system. They have some of the advantages of steam and other advantages that steam systems do not have. Owing to the larger size of pipe necessary, the first cost is somewhat greater, but they are more efficient owing to the fact that it is easier to maintain water at a uniform temperature than steam. Another advantage is that temperature radiating surfaces can be controlled easily and can be anywhere from room temperature up to 190 deg. F., or even higher in certain forms of hot water systems. One of the disadvantages of hot water heating systems, in comparison with steam, is that they cannot be made to respond as quickly to sudden changes in demand for heat. Hot water systems have about the same efficiency as steam systems.



Typical Boiler for a Hot Water Heating System

Heating systems utilizing steam and hot water with the natural circulation of cold air around warm radiators have the advantage over hot air systems that each room has a separate source of heat. Moreover, the systems are not so easily affected by wind, no dust or gas is carried to the rooms and the source of heat is independent of the position of the boiler. In the case of hot water systems, careful installation is required in order to insure that the circulation will not be stopped, resulting in frozen radiators.

Oil and gas are adaptable to all forms of heating, in-

cluding stoves, furnaces and boilers, and their use is desirable in localities where they are available at reasonable costs. They are clean, require little attendance and eliminate the necessity of disposing of ashes. Ordinarily, oil is cheaper than gas, except in locations near natural gas fields. In selecting an oil burner, care should be taken to choose one that is adaptable to the boiler so as to be able to use a reasonably cheap grade of oil, No. 3, or below. It should be as fully automatic as possible with simplicity of adjustment.

Automatic Heating Systems—Fan Units

Automatically controlled heating systems, which require no janitor or special attendant, may include unit fans heated with steam from a central boiler plant, unit fans heated with gas or electricity, electric heaters, direct-fired gas heaters, and direct-fired oil heaters. Fan units have been used very successfully for some time. They are operated electrically, using steam and in some cases electric resistance for radiation. Where large spaces are to be heated, this can be done more economically with unit steam heaters than with radiators. The all-electric type of heater is more costly to operate but is very convenient for places where it is not practicable to install a boiler. The heat output of steam unit heaters is ordinarily regulated by thermostat control of the motor, steam pressure being allowed to remain on the heating element at all times, except when the steam is cut off entirely.

A desirable arrangement in buildings with high ceilings is to control the flow of steam to the heater by automatic control valves and permit the fan to run continuously in order to reduce the accumulation of excess heat in the area above the working zone. In installations where the steam pressure is lowered for use in unit heaters by means of a reducing valve, the heating element should be designed for a working pressure not lower than the initial pressure of the steam before it is passed through the reducing valve, owing to the possibility of the full pressure being applied. In a small heating system, care should be exercised in selecting the size of the unit heaters and determining the method of control, as a system composed of a few large units with fan control only will impose too great a fluctuation in the load on the boiler.

Some fan units are built of standard type cast-iron radiators, with the fan blowing between the sections. These radiators can be installed in enclosed cabinets located directly on the floor. There is also a new form of unit heater which is entirely electrical and does not require steam. Unit heaters have considerable advantage over all other forms, especially for the heating of small areas, where open fires are not permissible and where other kinds of fuel can not be handled.

Direct-Fired Gas and Oil Heaters

Gas steam radiators are used in small buildings in the natural gas belt and are successful where proper ventilation is provided and where heaters are connected to flues for the discharge of fumes. Special care must be exercised in extremely cold weather to keep radiators from freezing when not in use. Gas-fired circulating heaters and oil-fired circulating heaters using kerosene or light oils, are becoming popular in some localities, especially in southern territory where the heating season is not long and where heat is sometimes required for only a few hours each day. These heaters are made in several stock patterns and sizes, capable of delivering from 20,000 B. t. u. to more than 100,000 B. t. u. per hour.

Taking the Proper Care of Turntables

By H. J. BARKLEY

Bridge and Building Foreman, Illinois Central, Carbondale, Ill.

THE maintenance of turntables is not always accorded the consideration that it deserves, particularly during the winter, and, as a result, it frequently becomes necessary to remove turntables from service for the purpose of making repairs at times when they can least be spared, whereas exercise of the proper care and inspection would have avoided the trouble. Proper attention to a turntable during the fall or early winter will do much to promote its operation throughout the winter without further repairs.

Probably the most important part of a turntable is the center bearing, and it is imperative that this mechanism be kept properly oiled at all times. It is no less important to avoid the formation of ice in the bearing by preventing the accumulation of water therein. Most railroads have a rule requiring the raising of all turntables at regular intervals for the purpose of inspecting the center rollers, and failure to comply with this rule should not be tolerated. It is particularly important during these inspections to determine that no loose bolts, sheared cotter keys, grit, or other objects have lodged on the roller paths. Where tables of the converted three-point-support type, operating on roller bearings, are in use, the oil around the bearings should be changed to a lighter grade on the approach of winter. Proper attention to such matters will do much to reduce to a minimum the tractive force necessary to move the turntable.

Circle Rail Should be Examined

The circle rail should be examined at the receiving point to determine whether the impact caused by engines moving onto the table has caused the circle rail to become battered under the end wheels. If this is found to be the case it may be necessary to adjust that end of the table in one of several ways. For instance, it may be found that the end tie on the receiving end of the table has been crushed, that the gap between the rails is too great or that the ends of the rails are battered or bent down. Any of these conditions will result in an increase in the impact on the circle wall.

If the circle rail is to be maintained in good surface during freezing weather, particularly if it is supported on wood shims or ties, care must be taken to insure that the pit is thoroughly drained. Moreover, if the circle wall of the pit is provided with a wood curbing, this curbing has a tendency to be pushed inward when the ground freezes and should be adzed where necessary to prevent its fouling the end of the turntable.

When the teeth of the gears of the turntable tractor become worn, the gears should be renewed in order to avoid any lost motion. In addition, the motors and wiring should be inspected periodically by the electrician.

In order to permit of the operation of a turntable without undue delays and expenditures for repairs and maintenance, the complete co-operation of the mechanical and maintenance of way departments is essential. Frequently a foreman, hard-pressed to accomplish other necessary work, may be reluctant to assign a man to work on the turntable as long as it is in operating condition, but this may be the means of avoiding delays and greater expense at a later date.

News from Washington

DEFINITE assurance of the purchase of 700,000 tons or more of rails in the near future is given in the reaction of the railways and the steel mills to the plan initiated by President Roosevelt for the allocation of a considerable sum for this purpose from the $3,300,000,000 public works fund. No definite statement has been made concerning the terms under which loans for this purpose would be made to the railroads, but the administration has made it clear that the fulfillment of this plan is contingent upon a reduction in the price of rails from the present base of $40 per gross ton.

Leaders in the steel industry as well as the railways have indicated their approval of the general features of the plan, and Joseph B. Eastman, transportation co-ordinator, has announced that the rail manufacturers will bid on 700,000 tons of rails, which amount represents the combined tonnage which the railroads are expected to pool for mass purchase at Mr. Eastman's instigation. In the meantime individual rail orders placed by the railroads aggregate in the neighborhood of 150,000 tons. The largest of these orders included one placed by the Chesapeake & Ohio for 31,480 tons early in September, and those of the New York, New Haven & Hartford and the Union Pacific for 20,000 tons each, announced late in the month. The directors of the Chicago, Burlington & Quincy have authorized the purchase of 25,000 tons, while other roads which have indicated their intention of purchasing rails if price readjustments are made include the Atchison, Topeka & Santa Fe, the Delaware, Lackawanna & Western, the Illinois Central and the Southern Pacific.

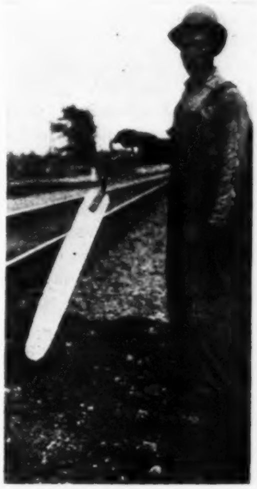
Evidence of the favorable reaction that has been accorded President Roosevelt's plan for promoting employment through the agency of rail purchases, is afforded by his announcement on September 27 that he hopes to extend the plan so as to provide federal aid also for the purchase of rolling stock and other equipment. The plan as a whole is in accord with the position taken by Mr. Eastman with respect to railway employment, in his comments on the President's decision not to apply the National Recovery Act to the railroads, when he said, "The President has decided that the railroads are not to be dealt with under the National Industrial Act. They have, of course, been subjected for many years to more comprehensive regulation than any code provides. But the fact that they are not within the N. I. R. A. makes it all the more important that the railroads play their proper part in the program of national recovery. One thing for them to do, as I have heretofore indicated, is to use every available dollar, as traffic and revenue increase, to put more men to work. There is so much deferred maintenance and other work which sorely needs to be done that this will not only help the country but be of the soundest of economy."

Although the railways are thus exempted from the adoption of the N. R. A. codes, this is not true of the railway supply industry. The Manganese Track Society has filed a code proposing minimum wages for common labor ranging from 30 to 40 cents in plants manufacturing trackwork, including switch stands, but excluding rail braces, compromise joints, tie plates and switch rods, except when furnished with switches, frogs, etc. Other groups of manufacturers are embraced within the scope of codes adopted or under consideration for general industrial classes such as the various subdivisions of the iron and steel industry.

The Railway Tie Association has also submitted a tentative code in which minimum rates of pay are placed on a sliding scale ranging from $10 to $15 per week, depending on the population of the cities in or near which the operations are conducted, and providing that wages may be paid upon a piecework basis at such rates that the average worker on piecework basis will, with reasonable diligence and ability, be able to earn the minimum rates of pay. The code definitely prohibits the fixing of prices in a clause stating that: "Nothing herein is to be construed as an intent to fix the selling price of ties, but this Code is intended to prevent or punish any flagrant offenses of selling below cost, depressing wages or other compensation as may be generally observed throughout the industry."

More About Tamping Ties from the End

AS WAS stated in one of the discussions which appeared on pages 334 and 335 of the July issue, the tamping of ties from the end by means of a wide thin blade "is not new, since the use of trowels or end tampers dates back many years." That it is not a universal practice, however, is indicated by the requests that have been received for more information on the character of the tool and the manner in which it is used.



Trowel Made From an Old Cross-Cut Saw Blade

Robert White, section foreman on the Grand Trunk Western, one of those who participated in the discussion in the July issue, has since sent photographs and additional information which are presented here. The trowel which Mr. White uses is a home-made affair, being fashioned from an old cross-cut saw blade from which the teeth have been removed. The trowel is about 34 in. long and 5 to 6 in. wide, being taken from the center portion of the saw where the blade is widest. Where old saws are not available, other spring steel of the proper thickness, width and length can be used. Untempered steel is not adapted for this use because when thin enough to be handled (about 18 gage) it is too easily bent out of shape. The handle shown in the illustrations is made of ½ in. round iron flattened at the end for attachment to the blade by means of two cold

The Foreman Should Test the Track, Marking Low Spots. The Men Then Remove Ballast From the Ends of Ties at the Places Marked

The Jackman Should Hold the Tie Tight Against the Rail While the Foreman Does the Tamping. To Secure this Photograph, the Jackman Took Mr. White's Place, Leaving the Lining Bar in Position

rivets. Some tools of this type are fitted with iron handles which are finished with a wooden grip.

In tamping for light or very light lifts, the blade is covered evenly with a thin layer of ballast by scooping the ballast with the blade itself; shovels are never used to load the blade. After the track has been jacked up the blade with its load is carefully inserted under the tie and withdrawn by a quick deft motion which is easily acquired by experience. In this way, the ballast is not bunched, but is left evenly distributed on the old bed. When done properly, the ballast is deposited from the end of the tie to a point about 16 in. inside of the rail.

For heavy lifts, up to 1 in. or more, the blade is covered in the same way with a heavier load of ballast, also evenly distributed, but coarser material can be used in this instance. It is inserted and withdrawn in the same manner as for the lighter lifts, but in this case is not pulled all of the way out, two or three inches of the blade being left under the tie. Second and succeeding loads are pushed onto the blade evenly by hand. It is then sent under and withdrawn as before, this sawing motion being continued until the space under the tie is full.

Other features of this method of tamping and its advantages and limitations are given in the What's the Answer pages of the July issue. A more detailed account of this tool and its use was also published in the May, 1927, issue.

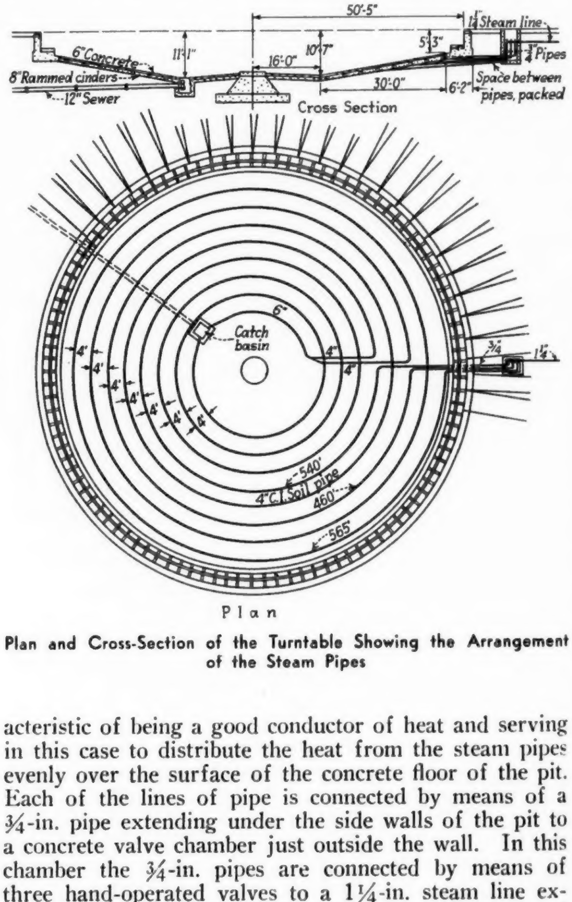
Install Steam Pipes Under Turntable Floor

BECAUSE the collection of snow and ice in enginehouse turntable pits during winter storms frequently creates a serious problem of operation, the Kentucky & Indiana Terminal has installed an unusual steam heating system under the concrete floor of its turntable pit in the Louisville (Ky.) yards to prevent delays in engine service due to this cause. The system was installed at the time the turntable was constructed and has proved an effective means of keeping the pit free of snow and ice. The pit is 101 ft. in diameter and 5 ft. 3 in. deep inside the circle rail, with a maximum depth of 11 ft. at a distance of 16 ft. from the center. The downward slope of the floor of the pit toward the center is, therefore, 0.18 ft. for each foot of horizontal distance.

View of the Turntable in Which the Heating System Was Installed

The Heating System

The heating system consists of three lines of 4-in. cast-iron soil pipe arranged to form what are in effect three concentric spirals with a distance of 4 ft. between successive loops of the spirals. The three lines of pipe are 540 ft., 460 ft. and 565 ft. long and are laid in an 8-in. bed of rammed cinders immediately below the concrete floor of the pit, cinders being used because of their char-



Plan and Cross-Section of the Turntable Showing the Arrangement of the Steam Pipes

acteristic of being a good conductor of heat and serving in this case to distribute the heat from the steam pipes evenly over the surface of the concrete floor of the pit. Each of the lines of pipe is connected by means of a ¾-in. pipe extending under the side walls of the pit to a concrete valve chamber just outside the wall. In this chamber the ¾-in. pipes are connected by means of three hand-operated valves to a 1¼-in. steam line extending from a connection with the heating system of the enginehouse.

Drainage of condensed steam from the system is accomplished through suitable connections of the 4-in. soil pipes to a concrete catch basin, 3 ft. square on the inside, located near the center of the pit, whence the water is removed through a 12-in. sewer pipe. Escape of free steam at the catch basin is prevented by using a quarter bend in the connection with the heating system to bring the outlet below the water level in the basin. Sufficient grade to permit ready drainage from the steam pipes to the catch basin is provided by the slope of the pit floor.

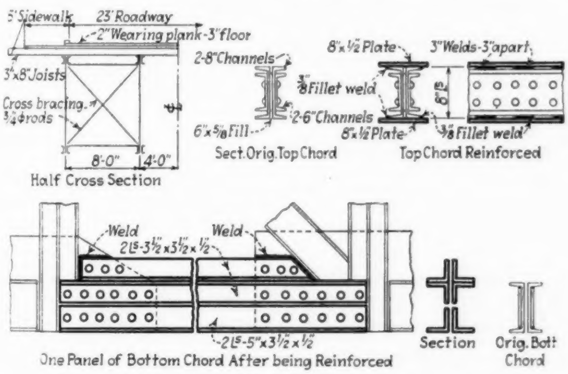
We are indebted for the information contained in this article to W. S. Campbell, manager and chief engineer of the Kentucky & Indiana Terminal.

Unusual Method of Repairing an Old Bridge

AN EXAMPLE of the adaptability of arc-welding to the repair and strengthening of an old steel bridge under unusual and decidedly unfavorable conditions is offered in work done by the Atlantic Coast Line on a viaduct over its tracks at Bell street in Montgomery, Ala. Incidentally, the project embodied an ingenious plan for the complete replacement of a section of bottom chord without resorting to the use of falsework.

The bridge in question, which was built in 1897, consists of a single span of 85 ft. supported at its south end on a rubble stone masonry abutment, and at its north end on a steel bent adjoining a reinforced concrete span over the tracks of another road. The span consists of four riveted deck trusses, spaced 8 ft. center to center, that carry a wooden deck composed of two layers of wooden planking on 3-in. by 8-in. joists that span transversely and rest on the top chords of the trusses at a spacing of 2 ft. The top chords are therefore subjected to combined bending and compressive stresses, and analysis showed that loads greater than those produced by 6½-ton trucks produced excessive stresses. In addition, the bottom chord members directly over the main track had suffered a loss of section of as much as 50 per cent from the action of locomotive blast and sulphuric acid fumes. Therefore, to avoid replacement of the span it was decided to undertake repairs and strengthening that would restore the metal lost by corrosion and cinder blast, and increase the capacity of the bridge sufficiently to permit it to be used by 15-ton trucks.

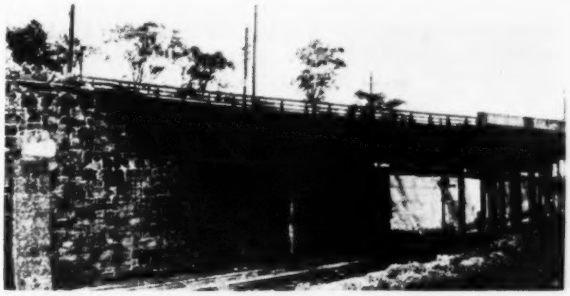
It was desired to avoid the use of falsework, both because of the expense involved and because of the difficulties imposed by restricted side and overhead clearances. It was also deemed desirable to carry on the work without disturbing the wooden floor, so that the operations would excite a minimum of local comment, which might have led to discussions concerning changes in the bridge. These considerations led to studies of the possibilities of arc-welding for applying the reinforcing material to the trusses, more especially to the top chords whose peculiar make-up made riveted additions impractical without the use of falsework, the tearing up of the wooden floor and the complete renewal of the top chord section. The methods employed in applying the arc-welding process to the reinforcement of the top and bottom chords of the bridge is illustrated in the drawing shown above.



Details of the Reinforcement and Repair Work

The top chord is of a decidedly unusual design. As originally constructed, it consisted of two 8-in. channels, two 6-in. channels and a 6-in. by ⅝-in. filler plate. This was reinforced by adding 8-in. by ½-in. cover plates on the top and bottom, which were stitch-welded to the flanges of the 8-in. channels by means of 3-in. lengths of ⅜-in. fillet welds spaced 3 in. apart.

The bottom chord in the panel directly over the track consisted of two 8-in. channels and two 7-in. by 5/16-in. side plates, but corrosion had reduced the section to such an extent that it was necessary to renew the member in its entirety. As it was desired to avoid the use of falsework, it was necessary to adopt a section for the new member that could be inserted piecemeal in such a way as to insure that the effective section in place was at no time less than the section of the old member in its deteriorated condition. This led to the adoption of a section consisting of six 3½-in. by 3½-in. by ½-in. angles, of which four were to occupy the location of the old member and the other two angles were to be located above and entirely clear of it. The old gusset plates were large enough to permit the connection of these two angles in this location. The procedure in replacing the chord members was as follows:



The Bell Street Bridge at Montgomery, Ala.

a. The new angles (A) were welded to the gusset plates above the old members.

b. These two angles had an effective section equal to one-half that of the old member, thus permitting one-half of the old member to be released. This was done by burning through the longitudinal center line of the two channels and plates and burning off the rivet heads so that the lower half could be removed.

c. The lower half of the old member was then replaced by the two new angles (B), riveted to the original gusset plates.

d. The connection rivets for the upper half of the old member were then removed, permitting the release of the remainder of the old member, after which the two angles (C) were riveted to the original gusset plates.

e. As there was sufficient space for them in the gusset plates, three rivets were finally placed in each end of the angles (A).

The program was carried through as planned, but the time of the welding was about 25 per cent greater than had been estimated, owing in part to interruptions due to the passing of locomotives under the bridge but mainly because of the vibration of the span under passing vehicles.

These vibrations were great enough at the time the work commenced to break the welding arc at the passage of each vehicle, but as the reinforcement progressed the stiffness of the bridge increased to such a degree as to permit of practically continuous welding. The project involved the application of approximately 1,700 lin. ft. of fillet welds which averaged about ⅜-in. in size, in addition to the riveting of certain connections.

The reinforcement of this bridge was carried out under the direction of G. G. Thomas, engineer metal structures, Atlantic Coast Line, Wilmington, N. C., to whom we are indebted for the above information.

Wood Preservation Declines Further in 1932

THE total quantity of timber given preservative treatment in the United States in 1932 amounted to 157,418,589 cu. ft., a decrease of 75,915,713 cu. ft., or 32.5 per cent from 1931, and the lowest for any year since 1919. These figures, together with the data given below, are taken from the annual statistical report on wood preservation in the United States in 1932 which was compiled by R. K. Helphenstine, Jr., forest service, United States Department of Agriculture, in co-operation with the American Wood-Preservers' Association.

Railway crossties given preservative treatment last year totaled 105,136,449 cu. ft., a decrease of 40,697,043 cu. ft. as compared with the number treated in 1931 and the smallest amount treated since 1918. In spite of this decrease, however, crossties comprised 66.8 per cent of the total timber treated in 1932 as compared with 62.5 per cent in 1931 and 57 per cent in 1930. The quantity of switch ties treated last year amounted to 8,603,872 cu. ft., a reduction of 2,293,660 cu. ft., or 21 per cent, below the 1931 total. Taken together crossties and switch ties comprised 72.3 per cent of the timber treated last year, while in 1931 they amounted to 67.2 per cent.

The volume of piles subjected to preservative treatment last year decreased 7,843,189 lin. ft., or 43.8 per cent, as compared with 1931, to a total of 10,077,675 lin. ft., the smallest figure for any year since 1911 with the exceptions of 1921 and 1915. The reduction in the number of poles treated last year, as compared with 1931, was 1,023,799, which brought the total down to 1,247,000 poles, the smallest number treated in any years since 1922. Seven of the eight classes of material treated last year showed decreases as compared with 1931, ranging from 21 per cent for switch ties to 61 per cent for wood blocks, while only one classification, cross-arms, showed an increase, 16 per cent. Of the total number of crossties treated, which was 35,045,483, or 13,565,681 less than in 1931 nearly 63 per cent were treated with creosote, 23.9 per cent with creosoted-petroleum mixtures, 9 per cent with zinc chloride, 3.2 per cent with zinc-creosote mixtures, and 1.4 per cent with miscellaneous preservatives.

As in previous years, oak ties ranked first in point of number treated, with 16,005,297, or 45.7 per cent of the total, while southern pine ties occupied second place with 6,275,560 treated, or 17.9 per cent of the total, Douglas fir was third with 3,308,395 ties, or 9.4 per cent of the total, followed in order by lodgepole pine, maple, ponderosa pine, birch, beech, gum, tamarack, hemlock and elm. Of the total quantity of switch ties treated, which was 103,246,473 ft. b. m., a decrease of 27,523,905 ft. b. m., or 21 per cent below 1931, 55.8 per cent were of oak, 19.6 per cent were southern pine and 13.2 per cent were Douglas fir.

The quantity of creosote consumed in the preservation of timber last year amounted to 105,671,264 gal., a decrease of 49,765,983 gal., or 32 per cent, below the consumption in 1931, and the lowest figure reported for any year since 1922. Only 19.4 per cent of this creosote was imported which compares with 27 per cent in 1931 and 31.9 in 1930. The amount of zinc chloride used declined 2,654,317 lb., or 25.7 per cent, to a total of 7,669,126 lb., while the consumption of miscellaneous salts, 869,240 lb., showed a reduction of 89,045 lb., or 9.3 per cent. Miscellaneous liquids used, 92,656 gal., decreased 27,970 gal., or 23.2 per cent.

Wood Preservation, 1909-1930

Year	Total Material Treated, Cu. Ft.	Number of Crossties Treated	Creosote Used, Gal.	Zinc Chloride Used, Lb.
1909	75,946,419	20,693,012	51,426,212	16,215,107
1910	100,074,144	26,155,677	63,266,271	16,802,532
1911	111,524,563	28,394,140	73,027,335	16,359,797
1912	125,931,056	32,394,336	83,666,490	20,751,711
1913	153,613,888	40,260,416	108,378,359	26,466,803
1914	159,582,639	43,846,987	79,334,606	27,212,259
1915	140,858,963	37,085,585	80,859,442	33,269,604
1916	150,522,982	37,469,368	90,404,749	26,746,577
1917	137,338,586	33,459,470	75,541,737	26,444,689
1918	122,612,890	30,609,209	52,776,386	31,101,111
1919	146,060,994	37,567,247	65,556,247	43,483,134
1920	173,309,505	44,987,532	68,757,508	49,717,929
1921	201,643,228	55,383,515	76,513,279	51,375,360
1922	166,620,347	41,316,474	86,321,389	29,868,639
1923	224,375,468	53,610,175	127,417,305	28,830,817
1924	268,583,235	62,632,710	157,305,358	33,208,675
1925	274,474,538	62,563,911	167,642,790	26,378,658
1926	289,322,079	62,654,538	185,733,180	24,777,020
1927	345,685,804	74,231,840	219,778,430	22,162,718
1928	335,920,379	70,114,405	220,478,409	23,524,340
1929	362,009,047	71,023,103	226,374,227	19,848,813
1930	332,318,577	63,267,107	213,904,421	13,921,894
1931	233,334,302	48,611,164	155,437,247	10,323,443
1932	157,418,589	35,045,483	105,671,264	7,669,126

Statement of Material Treated By Classes (Cu. Ft.)

Together with consumption of creosote and zinc chloride

Class	1932	1931	Decrease	Per Cent
CrossTies	105,136,449	145,833,492	40,679,043	27.8
Switch Ties	8,603,872	10,897,532	2,293,660	21.0
Piles	6,815,532	12,119,880	5,304,348	43.8
Poles	21,947,200	39,966,062	18,018,862	45.1
Wood Blocks	490,184	1,256,567	766,382	61.0
Crossarms	370,904	319,625	51,279*	16.0
Construction Timbers	10,120,582	16,624,072	6,503,490	39.1
Miscellaneous Material	3,933,866	6,317,072	2,383,206	37.7
Total	157,418,589	233,334,302	75,915,713	32.5

*Increase.

Treatment of Miscellaneous Materials (Ft. B. M.)

	1932	1931	1930	1929
Lumber	33,994,619	43,119,020	76,244,055	87,972,030
Fence Posts	2,995,174	13,468,058	17,843,001	10,904,180
Tie Plugs	652,489	1,149,058	1,779,215	2,018,147
Crossing Plank	392,830	2,248,946	2,552,370	273,588

Crossties Treated, by Kinds of Wood and Kinds of Preservatives—1932. Number of Ties

Kind of wood	Treated with cresote —1	Treated with cresote petroleum —2	Treated with zinc cresote —3	Treated with zinc chloride	Treated with miscellaneous preservatives	Total	Per cent of total
Oak	13,431,910	1,214,841	657,251	641,310	59,983	16,005,297	45.7
Southern pine	5,190,222	923,051	....	161,376	911	6,275,560	17.9
Douglas fir	98,894	2,246,137	1,342	779,988	182,034	3,308,395	9.4
Lodgepole pine	....	1,235,111	365,426	94,760	....	1,695,297	4.8
Maple	796,924	306,665	....	543,027	41,300	1,687,916	4.8
Ponderosa pine	....	1,388,080	....	....	....	1,388,080	4.0
Birch	605,994	372,338	....	115,000	41,300	1,134,632	3.2
Beech	635,953	281,353	....	125,000	41,300	1,083,606	3.1
Gum	717,974	179,725	....	....	....	897,699	2.6
Tamarack	....	36,759	....	341,849	102,000	480,608	1.4
Hemlock	....	4,189	....	347,370	25	351,584	1.0
Elm	43,347	23,836	....	7,000	....	74,183	.2
Miscellaneous	395,100	163,388	91,357	9,759	3,022	662,626	1.9
Total	21,916,318	8,375,473	1,115,376	3,166,439	471,877	35,045,483	100.0
Per cent of total	62.5	23.9	3.2	9.0	1.4	100.0	

1—Includes distillate coal-tar creosote, creosote coal-tar solution, refined water-gas tar and water-gas tar solution.
2—Includes distillate coal-tar creosote, creosote coal-tar solution, refined water-gas tar and water-gas tar solution in mixture with petroleum.
3—Includes distillate coal-tar creosote, creosote coal-tar solution, refined water-gas tar and water-gas tar solution in mixture with zinc chloride.

Roadmasters Association Holds Convention "in Print"

In lieu of a regular annual meeting, reports of officers and committees, together with discussions, are presented on this and following pages

THE Roadmasters and Maintenance of Way Association, like other similar organizations of railway officers, has held no convention since 1930. Its convention has just been postponed for the third consecutive year. To bridge this gap in a hitherto unbroken record of 50 years, *Railway Engineering and Maintenance*, which has long given its October issue each year to a complete report of the meeting of this association, devoted its October, 1931, issue to the Roadmaster, with tributes by railway officers to his place and responsibility in the railway organization. Again in 1932, which marked the golden anniversary of the founding of the association, this publication devoted its October issue to an historical review of the organization.

Abandonment of the convention for a third year added still further to the seriousness of the problem confronting this organization in keeping alive interest among its members. Moreover, the reports prepared by the committee for presentation at the 1931 convention had not yet been published and distributed to the members and there was danger that the large amount of valuable information contained in them would be lost if it were not soon made available. Again *Railway Engineering and Maintenance* offered its services to the association in a proposal that the reports of these committees be made the basis for a Roadmasters "Convention in Print" issue in October, in which issue railway maintenance officers have heretofore been accustomed to look for reports of the Roadmasters' conventions. This plan received the enthusiastic approval of the executive committee of the association. It also received the endorsement of the officers of the Track Supply Association.

Accordingly, the reader will find below what is to all purposes a complete convention report, including a message from President Elmer T. Howson, reports of T. F. Donahoe, secretary, and James Sweeney, treasurer, and of the five committees, and a statement by D. J. Higgins, president, and L. C. Ryan, secretary, of the Track Supply Association.

Report of the President

THREE years have now elapsed since we last met in convention. In this interval, the first break in these annual meetings since our association first met in 1883, there have been many developments of interest to our members. Therefore, I welcome the opportunity to report to you on the changes that have taken place and on the present status of our association, the oldest in the engineering and maintenance of way department and ante-dated by few in the entire railway industry.

When our 48th annual convention was adjourned on September 18, 1930, it was with the full expectation that we would meet in regular session a year hence. Your officers undertook their work promptly, organizing committees to study and prepare reports on the various subjects selected and otherwise prosecuting the work of the organization. The committees, which were made up largely of members who volunteered for this service, likewise undertook their various assignments with enthusiasm, with the result that their reports were presented to the executive committee in June, 1931, in practically complete form. Late in July, however, we were advised that it was the desire of the executives of our railways that our association, in common with other similar organizations of supervisory railway officers, should forego conventions for the time being in order to avoid the taking of our members from their regular duties. Your executive committee promptly acceded to this suggestion and the executives of the various railways were notified of this action. The letters of commendation that were received from these executives confirmed the judgment of your officers in taking this action and testified to the high esteem in which our organization is held.

In the summer of 1932, your officers were confronted with the necessity of deciding again whether to proceed with a meeting and after consulting a number of executives, decided once more to postpone the meeting. This action likewise brought many letters of commendation from executive officers of roads with which our members are connected. This action was taken with profound regret, for this meeting would have been the Golden Anniversary meeting, celebrating the completion of 50 years of the association's life.

Early in July of this year, the members of your executive committee met for the third year to discuss the advisability of proceeding with a convention. It was recognized that while we are now emerging from the depression, the improvement was not yet sufficient to justify the thought that we were yet out of the crisis and approaching normal conditions. It was, therefore, decided to call off the convention for the third consecutive year. This left our association with the reports still in hand of the committees that were prepared for presentation at the 1931 convention. These reports contain much information of interest to our members and of value to the railways by which they are employed. Yet the reports were unavailable to our members, and might soon become out of date.

In this dilemma, *Railway Engineering and Maintenance*, which has for years printed the reports of our committees for use of our members at the convention, came forward with a suggestion that, in view of the impracticability of holding a convention, it publish the reports of these committees together with reports of the association's officers, in a Roadmasters Convention in Print Issue, copies of which would be sent to all members of our association as well as to other maintenance officers who are subscribers to that publication. This of-

fer was accepted with gratitude and through this means the work of our committees is now made available to you.

An association such as ours derives much of its momentum from its annual meetings where its members gather to debate topics of common interest and to increase their acquaintance among men of similar experience and responsibility. In the absence of such meetings, it is but natural that interest will lag. Yet, every contact with the members of the Roadmasters Association reveals a keen interest in the organization. To maintain this interest, a news bulletin has been issued at intervals, to inform the members of the activities of its officers and committees and to bring to their attention news of interest regarding their fellow members.

Your officers point with pride to the financial status of our association, as shown in the joint report of the secretary and treasurer appearing below. Your association still has $4,291.81 in the treasury, or only $612.20 less than the $4,904.11 held at the close of the last convention. This record has been made possible by the most careful control of expenses and by the willingness of your salaried officers to reduce their compensation to nominal amounts. This has made it possible to remit the dues of all members for the last two years and the executive committee has, at a recent meeting, extended this practice for the year 1934.

Throughout the period since our last convention, the officers and members of the Track Supply Association, as heretofore, have co-operated with our association at every opportunity. We eagerly await the time when they may resume their exhibits in order that we may see the new developments in track materials, tools and equipment.

I want above all to express my personal appreciation to the officers whom you selected to work with me. To these men, especially, and also to the chairmen and members of committees and to the membership at large, I owe a debt of gratitude for the assistance which they have so graciously given me on every occasion.

Just a word with respect to the future. Your executive committee will meet shortly to select new subjects and new committees and to plan anew for a convention in 1934. It is hoped and confidently expected that conditions will have so improved by that time as to justify a meeting. Your officers are making every plan for a convention in 1934 that will establish a new high record for interest in an association that is already more than a half century old.

Joint Report of the Secretary and Treasurer

The following report is presented for the period beginning September 1, 1930 and ending August 31, 1933:

Receipts		
On hand September, 1930		$4,904.11
64 new members		319.00
42 associate members		135.00
Dues		2,233.00
Sale of proceedings		1,789.76
Interest on Liberty bonds		244.38
Interest on Federal Mortgage Co. bond		90.00
Interest on building and loan stock		108.12
		$9,823.37
Expenditures		
Salaries of officers		$2,975.00
Expenses of officers and committees		92.70
Printing and stationery		1,513.00
Convention expenses		334.50
Stenographic hire, postage, etc.		543.65
Bonds of treasurer and secretary		67.50
Purchase of bond		5.00
Tax on checks		.12
		$5,531.56
Balance September 1, 1933		$4,291.81
Cash in bank	$ 229.10	
Liberty bonds	4,062.71	
Total on hand		$4,291.81

T. F. Donahoe, Secretary.
James Sweeney, Treasurer.

Routine Track Inspection—Its Purpose, Scope and Value

REPORT OF COMMITTEE

L. M. Denny
Chairman

It is generally accepted that some form of inspection is necessary to insure that the track and roadbed are being kept to the required standards. Experience has shown that detail inspections at frequent intervals are also necessary to the end that defects which, if neglected, might develop into unsafe conditions may be discovered and corrected while they are yet in the incipient stage. Replies from representative railways in every section of the country to a questionnaire sent out by the committee indicated no dissent from the premises that track inspection is necessary. They did disclose, however, a wide difference in the methods employed by different roads in meeting this requirement.

Until recent years it was an almost universal custom to require the section foreman, either personally or through a specially assigned subordinate known as a trackwalker, to make a daily inspection of all main tracks and switches on his section. Special conditions which might interfere with traffic, such as sliding cuts or fills, unstable rock cuts, etc., were cared for by assigning watchmen, either temporarily or permanently as conditions required. Since the latter do not fall within the purview of the subject as assigned, they will not be mentioned further.

Many of the early railways were laid with longitudinal wooden stringers to carry the flanged wheels of the cars and locomotives. The unprotected wood surface quickly wore out, and an iron strap was added to reduce this damage. Great as this improvement was, it introduced a hazard which required constant vigilance to overcome. The only practical method that could be devised for securing the straps to the stringers consisted of light drift bolts driven through countersunk holes in the straps. Within a short time after application, the straps became somewhat loose and eventually the receiving ends showed a tendency to curl up during the passage of trains. As wheel loads increased, the trouble became more acute and "snake-head" rails became a real menace to travel and were so recognized by the railways and the public.

Since there was no possibility of avoiding the trouble, efforts were made to minimize it. As a result, men were detailed to follow every train to straighten the straps

and redrive the drift bolts, as well as to look for other defects which were common to this type of track. As track design was improved, this form of hazard passed with the discarded strap rail, but others followed and the system of trackwalkers that had been developed was retained in modified form, since experience gave many impressive lessons with respect to the importance of regular and thorough track inspection.

Steel rail supplanted the old iron rail, angle bars succeeded fish plates, ballast, sometimes of poor quality, was becoming a standard material for track construction and other improvements were being made. Despite these advances, however, the rail was light, the angle bars were poorly designed, the bolts left much to be desired, drainage was decidedly inferior and the untreated ties decayed so rapidly that in most track there were constantly large numbers of ties that did not adequately support the rail. In addition, no form of protection was provided against rail cutting or against the tipping and spreading of the rail, except the inadequate designs of rail braces then in common use. At the same time, wheel loads were constantly becoming heavier and train speeds were increasing.

Broken rails, angle bars and ties; spreading track, tipping rails and surface and line-bent rails; creeping of the rails to produce tight or open joints, shifted frogs and, therefore, kinked line at turnouts, binding at stub switches or open points at split switches; these and many other equally difficult conditions, such as sliding cuts and embankments, confronted the maintenance forces of the second period of railway operation. To minimize these hazards, every road made an inspection of the track at least once daily, some required that two inspections be made, while a few instituted, in addition, a system of night inspection.

Obviously, the foreman could not make even the minimum of one inspection daily and also properly supervise his work. For this reason, the system of employing trackwalkers, which had been developed originally to prevent snake-head rails, was continued and became a settled practice, the foreman being required to make a personal inspection at intervals differing on different roads, but ranging from every other day to once a week.

Many of the Early Hazards Eliminated

Although conditions continued to improve, the system of track inspection remained unchanged, except that many roads abolished Sunday inspections. During the last 20 years, however, still more rapid progress has been made in the strengthening of the track structure. The weight of rail in common use today vastly exceeds that of a half century ago. Similar improvement has been made in the efficiency of joint fastenings. Tie plates and anti-creepers are developments of the last 20 years. Combined with these improvements, heavy switch construction, wider roadbed, better drainage, more and better ballast and the trend toward permanent types of bridges, have in large measure eliminated the hazards of the past.

This should not be interpreted to mean that the committee believes that all hazards to railway operation have been removed. On the contrary, as an indication that they have not, it should not be overlooked that parallel with these improvements in track construction and the strength of the track structure, sometimes slightly but more often far in advance, cars and locomotives have from the beginning increased in size and weight. Likewise, there has been a constant increase in the average speed of trains. Thus, as improvements in track and roadway have eliminated many of the hazards that have been mentioned, the developments in locomotives and cars and in train operation have continued others or introduced new ones that were unknown to early maintenance officers. For these reasons, track inspection remains as important today as it was in the beginning.

Up to 20 years ago two methods of making a track inspection were open to either the foreman or trackwalker. It could be made on foot or from a hand car or velocipede. Many maintenance officers insisted, and still do, on the former method on the theory that the inspection will be more thorough. Others permitted the use of velocipedes in the belief that the capacity thus provided to carry additional tools and supplies permitted the correction of many defects when they were discovered and that this materially increased the benefits derived from the inspection.

New System of Inspection Developed

In view of the virtual elimination of slides and falling rocks and of the hazards created by light track and bridge construction, some maintenance officers began to question the results they were getting from the system of track inspection then in vogue. At this time also a new factor had appeared, since the motor car had been perfected to the point where dependable and safe one-man cars were available. One of the first roads to make a marked departure from established practice was the Lehigh Valley. This road made a thorough investigation of its method of track inspection, as a result of which it concluded that it was securing few tangible advantages from it. This conclusion led to a practically complete elimination of the system of trackwalkers and to the substitution of one track inspector for each supervisor's district. He is provided with a motor car and is required to cover the entire district every working day. He reports to the various foremen any defects or other conditions that require attention.

Signal Maintainer Inspects Track

On the other hand, the Union Pacific, after a similar investigation which led to the same conclusion, has adopted the practice of requiring the signal maintainer on lines equipped with automatic signals, to inspect both the track and the signals. He makes immediate report to the section foreman of any defects or other conditions he discovers that might cause an accident or interrupt traffic.

Following the same line of thought, other roads have made changes which did not affect the basic method of inspection. Several roads reasoned that if a Sunday inspection was unnecessary, it was equally logical to forego it on the remaining days of the week. Others, unwilling to go to this length, require an inspection on alternate days, or, in some cases, semi-weekly. In practically all of these cases, however, the underlying thought has not been to relieve the foreman of any responsibility for the patrol or its results. For this reason, he is required to make a personal inspection once or twice a week.

Many other variations in the basic method of inspection have been developed, since nearly every road has made some changes as a result of the improved track structure, but the examples given are typical. They are important primarily because they indicate a growing belief that the current inspection practices required revision to bring them into consonance with modern track and roadway conditions. They also indicate the tenacity with which established practices persist even in the face of new conditions.

Heavier rail, better joint fastenings, treated ties, tie

plates, anticreepers, wider and stronger roadbed, improved drainage, the almost universal use of motor cars, the adoption of power machines and tools in maintenance and the introduction of welding as a means of rebuilding rail ends, have so reduced the requirements of routine maintenance that for some years there has been a steady decrease in the number of men required for regular maintenance work. On numerous roads this situation has led to a partial or complete reorganization of the section and extra gangs and this, in turn, has still further reacted on the practices with respect to track inspection.

On some roads the section gang has been reduced virtually to a skeleton organization, without any change in territory. On others, the number of sections has been reduced by extending the territory of each gang retained, with little or no reduction in the total number of men. In the first case, the heavier work of surfacing, renewing ties, cutting the right of way, etc., is done by gangs specially organized for this purpose, leaving the section gang to care for routine work, including patrol. In the second case, the section forces are expected to do the bulk of the work, except laying rail, ballasting, etc., which tasks are handled by gangs specially organized and equipped for this service.

A Light Motor Car Is a Valuable Aid in Inspections

As these changes in organization have taken place, two facts have become obvious. In the reduced gangs, the ratio of the time required for patrol to the total time worked was too high, whether the inspection was made by the foreman or the trackwalker. In fact, observation has indicated that when the foreman made his inspection he was generally accompanied by the entire gang. Where the section limits were extended, the new sections commonly ranged up to 12 or 13 miles long, with a few as much as 18 miles. In such cases, it is apparent that the inspection could not be made on foot. Here also, the time involved in making the inspection was out of proportion to the total time of the gang. And, finally, if the foreman was to be required to do patrol duty, the gang would be without supervision for periods of too great length.

On several of the roads that extended the section limits, notably the Chicago, Burlington & Quincy and the Chicago, Rock Island & Pacific, these considerations led to the abandonment of the former system of patrol and the substitution of a plan somewhat similar to that followed by the Lehigh Valley in that it relieves the foreman of responsibility for the regular patrol of his section. These roads went further, however, and made their inspectors considerably more important, in that they are also contact men between the roadmasters and the foreman. In addition to inspecting the track and roadway, they make many minor repairs and line up and keep the work of the various sections properly co-ordinated. Every inspector is provided with a light motor car and is required to cover his entire territory, ranging from a minimum of 30 miles on double track to 75 miles on single track, at lease once every working day. A detailed description of the plan as it is applied on these two roads will be found in *Railway Engineering and Maintenance* for January, 1932, page 39, and for October, 1932, page 621.

Advantages and Shortcomings

While incidental mention has already been made of some of the advantages and shortcomings of the several methods of track inspection which have been reviewed, they will now be discussed in more detail. During the period when it was the common practice to patrol the track seven days a week, and even long after Sunday patrol was discontinued generally, intelligent native and other English-speaking labor was plentiful. For this reason, there was seldom any difficulty in obtaining reliable trackwalkers. As the country developed industrially, however, these workmen were attracted by the higher wages paid by manufacturers and left railway service. They were replaced largely by unskilled emigrants from southern and eastern Europe, who not only failed to learn the language but roamed from one end of the country to the other in search for better wages or more agreeable working conditions.

While a relatively few individuals among these laborers developed into dependable trackwalkers and could be relied on to the same degree as native labor, the majority took little interest and felt little responsibility with respect to track inspection. Not infrequently, a foreman has found himself in charge of a gang, not a single member of which was experienced in trackwork. In this situation, as it also often occurred with gangs of considerable experience, there was no one competent to make a switch inspection. If the foreman made the inspection himself, he was compelled to leave an inexperienced or only partly trained gang without supervision during the time required to make the inspection.

While these conditions were not universal, they were prevalent enough to raise serious question in the mind of many maintenance officers with respect to the value of the system as it was being employed. Typical of this attitude, one member of the committee, in discussing this phase of the subject, said that "the duties of a trackwalker or track patrolman are many. He is expected to inspect everything on the right of way, including tracks, turnouts, roadbed, fences, gates, grade crossings, cattle guards, bridges, telegraph and telephone lines and other items which go to make up the fixed property, except signals. He must report at once to the foreman any defects he is unable to repair. It is a grave question whether there is an important percentage of our track laborers who are capable of performing intelligently the many duties expected of a trackwalker. Many of these men are illiterate and relatively few of them understand our language. For these reasons, I am definitely in favor of employing a more intelligent and more competent class of men as track inspectors. In my opinion the assignment of such men as regular inspectors would not only add to the safety of train operation, but it would demonstrate marked economy in this phase of maintenance."

Inspection Sometimes Perfunctory

Some of the investigations made to determine the merits of the practice of employing local trackwalkers for each section disclosed that track inspections were often being made perfunctorily, thus completely nul-

lifying their value. Another phase that should be considered is the relatively high cost. A properly made inspection requires substantially a fixed amount of time. When the gangs were large and the sections short, the ratio of this time to the total time of the gang was low, say from 5 to 12 per cent. With the longer sections and smaller gangs now employed on many of the roads today, this ratio may run as high as 40 per cent, leaving this item badly unbalanced.

To a large degree these shortcomings have influenced those roads which have been mentioned in making the decision to employ a system of track inspection which would so far as possible eliminate them. While based on the same idea and having a number of features in common, the practical application of the plan on the three roads shows a wide divergence.

Relieves Foreman of Routine Patrol

On all of these roads the foreman is relieved of all responsibility for the routine patrol of his track, but this does not extend to periods of storm or other emergency. The inspector is given as much territory as he can cover thoroughly in a day on a motor car, and he is required to notify the foreman at once of all but minor defects which he himself can remedy. All of the roads employ only men of high intelligence and long experience in track work. Here the point of divergence is encountered. The Lehigh Valley adheres more nearly to the idea that a track inspector should not be burdened with other duties.

On the Rock Island, inspectors rank slightly higher than foreman and foremen are promoted or properly qualified men from the engineering corps are transferred to the job. In addition to their primary duty of inspecting the track, they are required to tend switch lamps, make certain repairs, transmit instruction from the roadmaster and coordinate the work of the sections. On the Burlington, the rank is still higher, being that of a supervisor with a supervisor's authority and duties, in addition to the track inspection which each supervisor must make daily over his entire district.

Trackwalkers Have Largely Been Dispensed With

As the committee views the matter, there are definite advantages in the system of inspection followed on these roads. The foreman is relieved of the necessity of patrolling his track and is thus able to devote the entire time of himself and gang to productive work. The ratio of the cost of inspection to total maintenance expenditures is lower than under the former system, even at its best. The higher wages which the position pays makes it attractive and enables the road to secure intelligent, competent men who have had the requisite training and experience which the job requires. Responsibility for failure to observe defects or unsafe conditions can be definitely placed. Finally, experience has shown that through constant contact with the several foremen on his territory and with the roadmaster, the inspector is kept alert and interested in his work. In other words, there have been no indications of a tendency to consider routine track inspection as a perfunctory matter. On the contrary, the officers of these roads say that it is looked upon as a job to be done thoroughly every day.

Question of Divided Responsibility Raised

Considerable criticism of the plan of using independent inspectors who cover more than one section has been voiced on the ground that it results in divided responsibility between the foreman and the inspector. Those who are following the practice report, however, that they do not find this to be so. The inspector is responsible for finding undesirable conditions if they exist; the foreman for correcting them when he is notified of them. If he does not do so, the inspector is clothed with enough authority, either of himself or through the roadmaster, to see that he does.

So far, the discussion has referred to the main-line roadway. Yards and terminals, however, constitute an important part of many districts. Conditions with respect to inspection in yards and terminals may vary widely from those on the main line. The importance of making regular and frequent inspections of tracks, turnouts, etc., in yards and terminals is no less than on main lines; in fact, the need for frequent inspections may be greater.

Conclusions

1. Frequent inspection of the track and roadway is necessary to insure safe and uninterrupted operation of trains.
2. The system of employing trackwalkers locally on each section for the purpose of routine inspection originated in maintenance requirements which have long since passed out of existence.
3. Owing to the general improvements which have been made in the track structure and to its greatly increased strength, the character of the hazards which make inspection necessary has been largely changed during the last two decades.
4. Because of these improvements and the use of power machines and tools, marked changes have been or are being made in the number and organization of the maintenance forces. As a result, the system of trackwalkers as heretofore generally employed is uneconomical and wasteful. Under this system, it is not always practicable to secure competent and reliable men to make the inspection.
5. Recently a new system has been adopted with certain variations on several roads, in which an inspector provided with a light motor car is required to make an inspection daily covering approximately six sections. Reports indicate that this plan has proved satisfactory and that it has demonstrated marked economy. The quality of the inspection has also improved, since only intelligent and competent men qualified by experience in track work are employed.
6. Owing to the wide diversity in operating, climatic and physical conditions, in traffic density and in forms of organization on different railways, the committee refrains from making recommendations with respect to particular methods of making routine track and roadway inspection. It does believe, however, that the methods heretofore followed are not suited to modern conditions

and are uneconomical. For this reason, it urges that maintenance officers make a thorough study of the entire subject as it affects their own roads, and endeavor to apply a method that is more in keeping with present day practices in other phases of maintenance.

Committee: L. M. Denny (chairman), supervisor, Cleveland, Cincinnati, Chicago & St. Louis, Indianapolis, Ind.; G. E. Boyd, Railway Engineering and Maintenance; A. B. Chaney, division engineer, Missouri, Pacific, Poplar Bluff, Mo.; M. J. Connerton, supervisor, Illinois Central, Chicago; L. J. Drumeller, assistant division engineer, Chesapeake & Ohio, Hinton, W. Va.; E. C. Goehrig, roadmaster. Chicago, Burlington & Quincy, Beardstown, Ill.; B. E. Haley, general roadmaster, Atlantic Coast Line, Lakeland, Fla.; H. H. Hahn, roadmaster, New York, Ontario & Western, Walton, N. Y.; P. H. Harris, division engineer, Texas & Ft. Smith, Port Arthur, Tex.; F. H. Masters, assistant chief engineer, Elgin, Joliet & Eastern, Joliet, Ill.; W. F. Monahan, general track inspector, Southern Pacific, San Francisco, Cal.; T. J. O'Sullivan, supervisor, New York Central, Canandaigua, N. Y.; H. W. Stetson, general supervisor maintenance of way, Maine Central, Portland, Me.; F. L. McMillian, supervisor, Alton, Joliet, Ill.

Discussion

H. R. Clarke (engineer maintenance of way, C. B. & Q.): This report is of interest, in that it sets out conditions under which track patrol or inspection was first resorted to, that is, the very weak track structure and the hazards incident to such construction, and reference is made to the very frequent inspection necessary —following every train. Then, as track became more substantial, such frequent inspection was not necessary and daily patrol became the general practice. This was justified by the still comparatively weak track structure and sufficient defects of all kinds were found and corrected to justify the patrol.

Later, as the track structure became still stronger and more adequate for the load it had to carry, the number of individual defects discovered decreased until, in many cases, the inspection became perfunctory and was continued more as a habit than because it justified itself. The improved track conditions and stronger structure that made possible such a reduction in track inspection also made possible other important modifications in organization and practice, of which most roads have taken advantage. That is, they are now realizing on the expenditures made over a period of years past.

One paragraph in the report that seems particularly worthy of comment is that pointing out the change in the ratio of patrol time to productive working time under the changed conditions that have confronted us during the past three years. A similar change in the ratio of supervision to labor was one of the factors that made necessary the radical reorganization of maintenance of way forces and methods.

It occurs to me that the committee could have done a constructive piece of work if it had called attention to the difference in importance of various lines, even on the same system, and recommended a patrol practice accordingly. Heavy traffic, high speed lines (especially those on which passenger traffic is important) justify almost daily patrol, while on less important lines every second day might be sufficient, and on even lighter lines twice or even once a week might be all that would be required, or could be justified. Some roads have put such an arrangement into effect, with a resultant saving and without any difficulty of any kind developing. Others, through habit and possible reluctance of division officers to change practices of long standing, are still patrolling even unimportant lines more frequently than seems necessary. If the committee had called attention to this and pointed out the varying conditions under which different patrol practices might be inaugurated, I believe it would have been of value.

P. J. McAndrews (roadmaster, C. & N. W.): The committee is to be complimented on the manner in which it has handled this subject and particularly for the conclusions, which set out so clearly the situation with respect to track inspection both past and present. While it was not the province of the committee to discuss matters relating to the organization or reorganization of the maintenance forces, except as they have affected the practices of track inspection, it should not be overlooked that the conditions which made necessary the adoption of various measures of economy, such as the lengthening of sections, have also been responsible for other changes in organization, including the adoption of the "inspector system" of track inspection.

We have made rather careful studies of the newer practices of some of the lines that have adopted this system, and as a result, we are led to the conclusion that it is the proper method. In this connection, at least one of the railways which is reported as having adopted the inspector system, took advantage of its opportunities some years ago to improve its secondary and other lighter traffic lines by laying heavy released rail, fully tie plating it, so that these lines were put in splendid condition to carry the traffic which it was then expected would continue indefinitely or increase. With the recent reductions which have occurred in traffic, however, these lines are not now subject to the demands of former years. As a consequence, it is my judgment that an inspection made every working day is unnecessary, and that one which is limited to the days on which switch lamps require attention should be sufficient.

While considering conclusion No. 3, which calls attention to the improvement in the track structure, it might be well not to overlook the fact that rail failures caused by transverse fissures are among the new hazards, since this defect was practically unknown when the lighter rail sections were in common use. It is true that through the use of the Sperry detector car, many transverse fissures are discovered before they reach the danger point. It is equally true that transverse-fissure failures do occur between the trips of the detector car. We also know from experience that signs of fissures have been discovered by section foremen who were making a detail inspection of their tracks on foot, which, if they had not found them, might have later contributed to an accident.

I have always been opposed to the practice of having assigned track walkers outside of large yards, but have favored, and still do, the plan of having the section foreman make a detail inspection by walking over parts of his section from time to time. To comply with the rules laid down by most roads, he should send a competent man, on the days when an inspection is required, over such parts of his section as he does not cover personally in going to and from work.

Conditions vary between wide limits, both on different roads and on different districts of individual roads, with respect to track, traffic, topography alinement, climatic conditions and the maintenance organization. Obviously, on a line equipped with automatic signals or, better yet, automatic train control, it is inconsistent to require a daily inspection by trackmen, when these automatic systems provide direct assistance toward preventing accidents which might occur as a result of rail failures, improperly fitting switch points, etc. A still further reason for this inconsistency lies in the

fact that signal maintainers usually cover their districts nearly every working day. With the signal maintainers and the track forces co-operating, and this is easily arranged, no track walkers should be required. Under such an arrangement, track inspection, aside from periods of storm, should interfere very little with track maintenance.

It should be stated that our requirement that section foremen inspect their tracks personally may interfere with their other duties under some conditions. We have not experienced any difficulty of this kind, however, because at present an exceptionally good class of labor is available. We believe that an inspection made by walking over the track is more effective than one made from a motor car. The operator of the car must not only watch in both directions for trains, but he must look for possible obstructions on the rail, and must also be alert to discover breaks in fences, telegraph and signal lines and observe many other items that are independent of the track itself.

To my mind, the inspector system seems to be a proper method of inspecting lines of light traffic, where there should be little difficulty in handling the motor car. Inspections on these lines should be considered sufficient, however, if made once or twice a week, instead of daily.

The Protection of Trackmen Working Under Traffic

Especially in Multiple Track Territory and When Using Noise-Making Equipment

REPORT OF COMMITTEE

R. H. Carter
Chairman

THE protection of trackmen working under traffic, especially in multiple track territory and when using noise-making equipment is one of the most important problems that maintenance of way men now have to contend with. Working conditions for trackmen have changed tremendously in recent years by reason of the increasing frequency of trains and the rapidly growing use of such noise-making power equipment as tie tampers, tie adzing machines, spike pullers, spike drivers, nut tighteners, power track drills, etc. These developments are helpful to general operating efficiency, but we must face the fact that they entail increased hazards for track workers. It is of the utmost importance that trackmen be educated as to these hazards and especially trained to meet the conditions growing out of the noise of such equipment and the necessity for extra alertness in keeping clear of trains.

There is a great deal that can be said about protecting trackmen. At the same time, there also is much to say concerning what trackmen can do to protect themselves. It is the opinion of this committee that safe workmen make safe work, and that safety efforts should be directed primarily along this line.

The first requisite for having safe workmen is to employ only men who are physically and mentally fit. On most railways every man seeking employment must pass a physical examination by the company surgon. This examination helps materially to maintain proper standards of fitness among the track workers. Where laborers of foreign nationalities are employed it is deemed advisable to have in the gangs (especially extra gangs) a few men who understand English. However, there is ordinarily not a great deal of difficulty along this line. Experience has shown that most track laborers of foreign extraction readily speak and understand English as it is commonly used in their work.

Having passed his physical examination satisfactorily, the new track employee reports to his section or extra-gang foreman, who is held responsible for training him properly in safety. The safe, efficient foreman will observe his new men closely, instructing them how this and that should and should not be done. He will tell them the safe way to get to and from the tool house. He will see that all tools are placed safely on the motor car or push car. The right kind of a foreman will see also that only tools in proper condition are used, and will not endanger his men or himself by taking chances with unsafe tools or equipment. By his example, in safe ways and methods, the foreman soon gains the confidence of his men and makes them understand that he will not permit any chance-taking in their work.

Most railroads have a book of Rules and Regulations for the Maintenance of Way Department. The safe foreman knows his book of rules thoroughly and abides by it strictly. On most roads any violation thereof by the foreman or any of his men calls for strict disciplinary action.

Noise-Making Equipment

All modern maintenance of way equipment is more or less noise-making. However, it is here to stay, and there is no doubt that its use will rapidly increase.

The question of safety protection may be considered under two heads. One is the avoidance of injury from the equipment, and the other is the avoidance of injury from trains. The twofold problem of safety, then, is the necessity for (1) devising ways and means of using the equipment efficiently with the minimum risk of injury and (2) working out means of protection against injuries from train movements while using it.

Let us consider first some angles of the problem imposed by the use of this equipment. Excavating machines, for example, have been the source of numerous accidents, many of them fatal. Statistics show that there is one death in every twenty-nine reported accidents from this source. It appears that the accidents with excavating equipment are chiefly the result of falling loads, which are caused principally by carelessness in fastening them, improper hitches, poorly designed lifting hooks, weak containers, cables not strong enough to stand the load or worn out from use, and careless handling of the boom or lifting cable. First-class equipment with frequent and thorough inspection, along with proper super-

vision and instructions to operators and helpers, a thorough understanding by all concerned as to the work to be done and the procedure to be followed, and strict compliance with rules will reap wonderful dividends in the prevention of personal injuries, and as well in long life for the machine.

Equipment for spreading filling material and cleaning ditches also is chargeable with its toll of injuries. A proper understanding among the operators and helpers, and adequate warning signals when moving the wings and adjustable blades will eliminate the hazards connected with this type of machine.

Handling such material as rails, ties, frogs, etc., causes most of the maintenance of way accidents. Unloading of ties is one operation that has caused many a broken limb. During these days of small section gangs when it is necessary to double up gangs to unload a car of ties, foremen are apt to get together for a chat and not watch their men unloading the ties to see that the men on the ground are in the clear when ties are being thrown from the car. It is a good practice to have one foreman in the car and the other on the ground when it is necessary to double up gangs. While the introduction of modern rail-handling equipment has eliminated some of the former hazards, it is unfortunately the fact that new hazards also have made their appearance.

In the handling of rail considerable use is made of self-propelled, reversible cranes and also of rail loaders mounted on flat cars. There is no question that with proper operation, rail can thus be handled cheaper, more efficiently and with fewer injuries than by the old hand method. However, if the foreman in charge and the operator of the crane are not alert someone is likely to get hurt. If possible, experienced men should be employed on rail-handling machines. Each of these men should be assigned to his particular position and carefully instructed. The machines, also, must be inspected frequently, especially the cables and rail hooks used in lifting. Then, with intelligent handling of the work by the foreman, accidents will not occur.

Falls Are Hazardous

There are now in use numerous machines for tamping ties. There is not much risk of accident in connection with their use. Probably most injuries are caused by men falling, due to clumsiness, or by the tamping tool falling on the man. A case of this kind occurred last year, when a man stepping from between the rails backed up, tripped and the tamping tool fell on him, bruising his hips and knees. He was slow in getting up, but—thanks to the vigilance of the assistant foreman, who continually carries a red flag—he was successfully assisted in getting clear of an approaching train.

In using tie adzers, men should be protected by placing safety guards on the cutting head and also requiring those working nearby to wear goggles, thus preventing possibly serious eye injuries.

The use of power track drills, arc welding machines and numerous other small, noise-making track devices likewise calls for considerable vigilance. Close supervision must be exercised to see that this equipment is kept in first-class condition and that the men are well trained in its operation so as to avoid accidents.

Injuries result also when using the ordinary track tools; in fact, too many occur, and they can nearly all be traced to one of two things. Either the tool was not in good repair or it was designed for another purpose than that for which it was being used. Foremen should see to it that their men do not use a tool that is not in good repair or is worn beyond the limit of safe operation. Also, tools should never be used for any purpose other than those for which they are designed. The foreman should always demonstrate to his men the proper way to use tools, and he should watch to see that his instructions are carried out and that men do not become careless in handling tools, with resulting hazard to themselves and the rest of the gang.

Accident prevention imposes a definite responsibility on the supervisor and the roadmaster. They should make sure by personal supervision that foremen are requiring their men to follow safe practices at all times, regardless of the urgency of the work to be performed. Discipline should be administered, if necessary, to correct failures in this respect on the part of foreman. Safety in connection with the use of equipment entails close and constant supervision. If a foreman permits his men to violate rules of safe practice, it is evident that adequate supervision of foremen's observance of safety rules is not being maintained. Success in the protection of trackmen demands persistent follow-up work by the supervisor or roadmaster, upon whom rests the responsibility for the safety of trackmen. Supervising officers should see that this responsibility is in turn imposed upon the foreman.

The hazards of accident become greater as operation expands from single to multiple tracks and the density of traffic increases. The observance of time-tables and rules governing the movement of trains should be strictly enforced on all well-managed railroads. However, accidents in connection with train movements still occur too often in maintenance of way work. Subsequent investigation of such accidents generally develops either the lack of proper flagging by the maintenance gang or the failure to heed the warning given by the train involved. Statistics show that accidents of this kind rank first among causes of personal injuries.

It is often possible, even where traffic is dense, to divert trains in multiple-track territory to facilitate the work of the maintenance forces and enable them to work under safe conditions. This is by far the best way to prevent accidents. It results in marked savings in the cost of doing the work and, in addition, better work and greater safety for the workers. On the Illinois Central's Chicago Terminal there are 10 main tracks for about six miles south to Fifty-First street, then 8 main tracks for several miles. There are also 2 main tracks west from Central station for 15 miles. Plans for the diversion of traffic from a track to facilitate maintenance work are always received by the transportation department in a spirit of hearty co-operation. The track is turned over to the trackmen after the peak hour in the morning and is released before the peak hour in the afternoon. Permission to obtain a track is received from the dispatcher. This is also the practice on other heavy traffic terminals provided with from two to six main tracks.

Audible Signals

When using noise-making equipment, it is the practice on most railroads for the foreman, assistant foreman or a specially designated man on watch, to use a police whistle for warning the men of approaching trains. However it is also common practice to use a whistle in section and extra gangs that are not using noise-making equipment.

Another interesting and novel practice for protecting trackmen is used on the Southern Pacific System, and is described below as it was outlined by C. H. Neal, roadmaster on that property.

> "When using noise-making equipment, we do not use a police whistle as a warning signal for approaching trains. When engaged in welding rail

joints, a 20-mile slow order is given all trains, covering the location where the welders are working. This order is effective between 7 a. m. and 6 p. m.

"In addition, we have what might be termed a 'portable indication.' This instrument consists of an indicator and a bell with the necessary wire and hooks to attach it to the wire of the automatic block signals with which our tracks are all protected. The indicator is hooked up to the signal system where the men are working and is actuated in the same manner as the block signals. Any train approaching from either direction throws the indicator to red and starts the bell to ringing, this commencing when the train is 2,000 ft. away. As soon as the bell starts ringing, the machine operator stops the machine. The men are instructed that when this happens a train is approaching, and they at once get themselves and their tools and equipment into the clear.

"It was necessary to evolve this idea because the majority of the track under my supervision is located in the canyon on the Sacramento river, where the curvature is very heavy and a train approaching cannot be seen until very close. This device eliminated the need of maintaining flagmen, with consequent delays to trains."

On the Santa Fe, also, police whistles are not used. Instead, the track is taken out of service when rail laying or surfacing work is in progress. While the same practice is followed on the Illinois Central, the police whistle is used in addition to warn the men of trains on the adjacent tracks. It is the custom on some roads when men clear approaching trains for part of the gang to go to one side and the rest to the other side to observe the passing train.

Selecting the Foreman

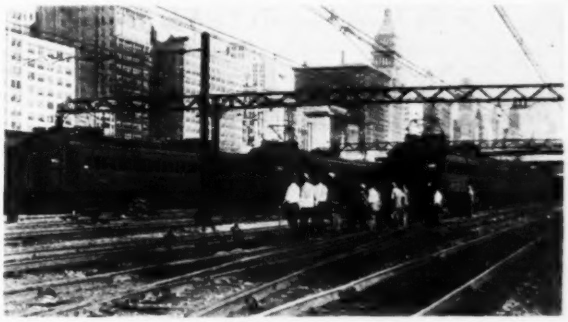
The selection of capable foremen for heavy maintenance work in dense traffic zones is highly important. It is the rule on most roads for foremen who have displayed more than average ability to be selected by the supervisor or roadmaster for such work. While most railroads bulletin positions for section and extra-gang foremen, the matter of getting capable foremen in busy territories can be worked out diplomatically by the supervisor or roadmaster. The foreman must be able to read timetables and to work intelligently with the dispatcher in regard to extra train movements and arrangements for taking tracks out of service at designated hours.

On some roads, large extra gangs are provided with a portable telephone which is hooked up to the dispatcher's line, and a complete line-up of trains is obtained each morning and at noon. The Southern Pacific goes even farther in this direction, and in a stretch of its single track territory where such portable telephones are used, every gang is equipped with a telephone and gets line-ups from the dispatcher morning and noon. However, because changes may take place in train movements after line-ups have been received, one man on each gang is charged with the sole duty of listening in on the dispatcher's line. Thus, he learns about any changes in the line-up and keeps the foreman fully posted. This method obviates any need for calling the dispatcher and permits the gang to work until the train is due. The latter advantage makes for considerable saving in time on rail relaying jobs. For instance, a train may be reported on the line-up as due at 2:00 p. m. but is delayed. The foreman immediately knows this and he continues working until such time as the train is actually due instead of closing up his track and waiting.

In addition to the foregoing, some gangs are equipped with a large blackboard on which is posted the time when trains are due. There is another column on the blackboard for inserting the time when trains pass. It is the telephone man's duty, as soon as he gets his morning and noon line-ups to fill in the "Train Due" column. As soon as the trains pass he also inserts this time. The blackboard is placed in view of all the men and the foreman and they know at a glance what trains are coming and what trains have passed. Changes in the "due" time of trains are made by the telephone man when received. The blackboards are used only by large gangs such as extra gangs. Section gangs work exclusively on the telephone line-ups.

Men Must Be Alert

As stated before, new men ought to be carefully instructed in safe working methods and should have all hazards connected with their work thoroughly explained to them by the foremen. It is a good practice to pair new men with experienced men. In busy terminals, where train movements are frequent and extra trains are likely to be dispatched in any direction at any time, the men should be trained to be on the alert at all times. Very few terminal tracks are spaced so that men can



Protection of Trackmen in Terminals Imposes an Exceptionally Heavy Responsibility on the Foreman

safely stand between tracks; therefore, they must move to adjacent tracks or elsewhere to be in the clear. In tunnels and in mountainous territory shelters are generally provided at intervals of about fifty feet. When men move out of the way of trains, they should all go the same side as that taken by the foreman. Of course, men working on a track that is out of service are permitted to remain on this track when trains pass on adjacent tracks.

It is worth repeating that vigilant supervision of foreman by the supervisor or roadmaster is essential to get results in the practice of safety. Mention was made of the administration of discipline as a means of correcting negligence of safety on the part of the foreman. The Illinois Central has in effect a system of demerit marks against the foreman's record, and when a foreman is disciplined to the extent of ninety demerits he is taken out of service.

Trackmen on the Illinois Central are not permitted to wear red outergarments or "bundle up" so that they are unable to move quickly or to see and hear clearly. Also, men are not allowed to wear overalls with a cuff turned up at the bottom for this may easily cause them to stumble.

On several railroads a set of safety instructions is issued to the foremen. Some of these safety rules are posted on bulletin boards at section headquarters for each day in the week and frequent checks are made by asking the foremen what the safety rule is for that particular day.

Statistics prove that, in general, safety work in railway maintenance of way departments is steadily showing increasingly good results. Some years ago, for example, motor-car accidents were deplorably frequent, but a great reduction in such accidents has been brought about by the adoption and vigorous enforcement of a code of motor-car rules. This is but one of many instances of similar progress in safety work that might be cited. The success thus far attained has been the direct result of the education of officers and employees in safety, the exercise of judgment in the selection of employees, the providing of proper tools and safety devices, close supervision, complete investigation of all personal injuries, rewards for outstanding safety records and the administering of discipline to those responsible for accidents.

On the Illinois Central, supervisors hold monthly safety meetings with the foremen; division engineers hold monthly safety meetings with their supervisors, which also are attended by groups of foremen, and superintendents hold quarterly safety meetings with the division staffs. A silver trophy offered by President L. A. Downs and known as the "President's Cup," is awarded yearly with appropriate ceremonies to the division showing the largest decrease in personal injuries during the year compared with the preceding year.

In the Illinois Central's Chicago Terminal

One of the foremost requirements of good safety work is the adoption of special measures to meet unusual operating conditions, for example, those encountered in the Illinois Central's Chicago terminal. Since all maintenance officers probably have similar problems in more or less degree, it may be of interest to present an account of some of the special difficulties and how it is endeavored to overcome them and protect the trackmen.

Over the terminal's multiple main tracks, as previously outlined, there is in normal times an exceedingly heavy movement of freight, through passenger and switching traffic. In addition, there is also an extensive high-speed electric suburban service from the Chicago "loop" to Richton, 29 miles south; to Blue Island, 19 miles southwest; and to South Chicago, 13 miles southeast. The safety problems of maintenance of way work incident to these conditions are intensified in this case by a high peak traffic density during the morning and evening suburban rush hours. In all, 54 through passenger trains and 500 suburban trains must be handled every week day over the tracks leading to Central station, in addition to numerous freight and switching movements. On the suburban tracks alone, there are handled during the morning and afternoon rush hours an average of 64 trains per hour, while during the summer of 1933, approximately 300 trains were handled on two tracks alone between the hours of 7 a. m. and 4 p. m.

One can readily appreciate that track work on the portion of the terminal where traffic is heaviest must be performed under extremely difficult conditions, especially from the standpoint of safety. The difficulty is increased by the fact that except in emergencies there are only about five hours a day when any work may be done on the electric suburban tracks. This is because of the restrictions imposed by the suburban rush-hour periods, during which men are ordinarily not permitted to work on the suburban tracks.

The protection of trackmen under these conditions imposes an exceptionally heavy responsibility upon the foreman. It is necessary, first of all, that the foreman be thoroughly familiar with the timetables and that supervising officers make sure that this requirement is fulfilled. Moreover, in addition to his other duties, the foreman must constantly be on the look-out to see that his men receive warnings of approaching trains in sufficient time to get in the clear. In some gangs working in locations where vision may be obstructed, one dependable man continually watches for trains and warns the men with a blast on a police whistle.

Conclusions

Good results in safety work cannot be achieved merely by passing out books of rules and regulations with instructions that they be read by all concerned, and thereafter taking it for granted that everything in the rule books will be strictly observed. Safety work that accomplishes its purpose calls for unremitting thought, diligence and hearty co-operation all along the line. Supervising officers should teach safety constantly by word and example and they should see that their instructions are put into practice. Considerate, careful instruction and supervision of both new and old employees will result in good safety habits and will build up an organization in which safe workers predominate. The temptation to take chances will not exist in gangs of this kind, because the men know it never pays.

The aim in safety work is to instill in the minds of the men the fact that chances must never be taken under any consideration. The chance-taker sometimes may save a little time or may conserve a little energy, and he may think that thereby he has gained in efficiency, but in the end the gains become losses, for chance-taking inevitably will end in accidents with loss of life and limb, and the loss of happiness to the wives and children of the chance-taker. It should be the effort of all of us to learn ourselves and to teach our men that it is never efficient or worth-while to take a needless risk.

Committee: R. H. Carter (chairman), supervisor, Illinois Central, Chicago; C. F. Allen, roadmaster, Chicago, Milwaukee, St. Paul & Pacific, Milwaukee, Wis.; H. L. Barr, roadmaster, Chicago & North Western, Boone, Ia.; L. Coffel, supervisor, Chicago & Eastern Illinois, Momence, Ill.; W. A. Davidson, roadmaster, Union Pacific, Kearney, Neb.; J. M. Fair, division engineer, Long Island, Jamaica, New York; William Hogan, supervisor, Baltimore & Ohio Chicago Terminal, Chicago; C. H. Neal, roadmaster, Southern Pacific, Redding, Cal.; J. E. O'Connell, supervisor, New York Central, Toledo, Ohio; J. A. Snyder, roadmaster, Michigan Central, Detroit, Mich.; R. J. Yost, roadmaster, Atchison, Topeka & Santa Fe, Chillicothe, Ill.

Discussion

G. T. Donahue (supervisor of track, N. Y. C.): The employment of men who are mentally and physically fit at the time they enter the service is not the only problem that confronts us. It is easy enough to hire men who have the requisite mental and physical qualifications for section labor, but after this is done, the question arises of keeping them in service, in accordance with their seniority rights, when they have reached the age of 60 or 65 years. Also, I believe the committee should have emphasized the desirability of having either the supervisor or assistant supervisor present where men are unloading ties or other heavy materials, to insure that they are adequately protected against negligence which might result in injuries.

A slow order is neither complete nor partial protection to trackmen. Essentially, it is put on to protect trains and only secondarily for the purpose of advancing the maintenance operation. Police whistles or some other accepted form of audible warning should be used regardless of any slow orders that may be in effect.

Taking a track out of service does not lessen the

danger to or from trains on adjacent tracks, and it should be borne in mind that a main track can never be taken out of service unless there is another one adjacent to it. When necessary to clear trains on an operated track, every man should be required to go outside of the outside tracks, including the foreman, for whom there should be no exception.

With respect to maintaining a special lookout, I think the attitude of the committee is excellent. In fact, on multiple tracks, even with gangs of 8 to 10 men, one man or the foreman is required to maintain a constant watch for approaching trains.

On the New York Central we are a step ahead of the committee in one respect. We are provided with forms on which we report the violation of safety rules, together with the discipline administered. This is done with a view of impressing on everybody the importance of safety work.

A. E. Preble (supervisor of track, Penna.): I consider this to be a remarkably able report. It also has another feature that should be commended. It is intensely practical and does not explore the realm of theory in any of its implications. In other words, everything that is said is true. Still, in studying the report, I find several questions arising, and I think there are several points that could well have been more definitely emphasized.

The Space Beneath Platforms Provides a Safe Refuge for Trackmen

In the second paragraph, this statement occurs: "There is a great deal that can be said about protecting trackmen; at the same time there is also much to say concerning what trackmen can do to protect themselves." I am wondering what the committee had in mind when it formulated that statement. Was it thinking of compulsion or of co-operation? Did it intend to suggest, at least by inference, a combination of the two? Or, was the emphasis intended to be on compulsion? Experience has proved very definitely that when you give a man a tool and instruct him how to use it, you are exercising supervision. No matter how lightly or kindly the supervision may be, it entails compulsion. For these reasons, as I see it, to have men think and work in accordance with the accepted rules of safety, constant supervision is required, the responsibility for which falls upon the supervisory officer.

In the fifth paragraph, mention is made of books of rules and regulations for maintenance of way employees. I am convinced that there should also be similar books containing safety rules for every employee, and that these rules should be given the same relative importance as those now in effect covering the work itself. Not only should the foreman know his safety rules to the point of being letter-perfect in them, but every laborer of average intelligence should know them or be dismissed from the service.

A careful study of the discussion of excavating machines discloses that two words stand out most conspicuously: Carelessness and inspection. Too much cannot be said on the necessity for regular and frequent inspection of power machines, because such a system writes PRODUCTION and SAFETY in capital letters.

One word, experience, summarizes the situation with respect to crane operation, particularly as it applies to unloading or laying rail, frogs, switches and crossings. Only men of known experience and reliability should be employed as crane operators. An inexperenced man will either slow up the work or cause the safety ledger to be posted in red, and he may do both.

I also find two excellent suggestions in the reference to the use of tools which may be condensed into these statements: (1) Defective tools should not be used; and (2) tools should never be used for any purpose other than those for which they are designed. My thought has been that any foreman who permits his men to use defective tools or tools for purposes for which they were not designed, is working at odds with the fundamentals of safety and that if he "doesn't snap out of it," he should be disciplined.

While I am fully in accord with the report as a whole, I am strongly opposed to the customs which, at least by implication, is approved by the committee. I refer to the practice of splitting a gang when clearing an approaching train, or for any other purpose. To my mind, there should be one positive rule, that all of the men in the gang must clear to the same side of the track as the foreman.

Under the subhead, "Men Must Be Alert," it is implied that the foreman should inspect the dress of his men every morning before they start their tour of duty, especially during the winter when accidents are more prevalent. I believe that in addition, the committee should have recommended that this inspection be extended to include the soles of their shoes, since a sure footing is a safeguard against slipping and falling.

Finally, it is stated in the conclusions that "the aim in safety work is to instill in the minds of the men the fact that chances must never be taken under any circumstances." When accidents happen, it is the common experience that employees endeavor to excuse themselves by saying that "it slipped," "it fell," "it dropped" or "I forgot." Inanimate objects never slip or drop of their own volition. This phase of the matter can be summed up in the statement that it was a man failure, caused primarily by neglect to perform in a workmanlike manner the work he was paid to do.

Geo. H. Warfel (assistant to executive vice-president, U. P.): This report hits the nail on the head when it advocates physical examination of all applicants for places on either section or extra gang. It should be a universal requirement. Reference is made to laborers who cannot readily speak or understand English. I think the time is rapidly approaching, if not already here, when the man who does not speak, write and understand English will find there is no place for him on a modern railroad. His place is at "common labor." The increasing use of power equipment and the higher efficiency demanded, as well as the safety of our ever faster and longer trains, remove track work from the category of "common labor." Call them trackmen.

There is no doubt that power tampers and similar

multiple-unit power devices keep the men using them from hearing trains and track cars. They also keep a man's eyes focused more constantly on his work and retard him when getting off the track. Where there are 1,800 to 2,000 ft. or even more of clear view, a watchful foreman and alert gang should need no special protection, but with any less distance on any but slow track a lookout man is desirable. If the foreman is doing the sighting or raising, or otherwise participating in the actual work, a man should be assigned to the lookout job until they get away from restricted view.

As to rail hoists, draglines, ditchers, spreaders and similar single unit machines, I think the most important safety factor for preventing injury to the men or accident to trains is the assignment of first-class, level-headed alert, safety-trained men as operators of such machines. The operator should be charged with full responsibility for continually inspecting and maintaining the machine, and authorized to stop use and refuse to operate it when any defect is discovered which in his opinion might create a real or potential hazard, until it is remedied. The operator sets the tempo and largely controls the mental or nervous tension of all the men around the machine. A supervisor can do no greater service to accident prevention than in selecting and training such operators.

The roadmaster or supervisor who has foremen who get together and chat while their men are unloading a car of ties or timber, or anything else for that matter, is a poor teacher, a poor leader and a poor disciplinarian. He cannot hope to be a roadmaster long. Unless he vigorously trains his men to watch personally the handling of every tie, stick or rail, and imbues them with the spirit of safety and responsibility, he is headed for the discard, on the railroad of today.

We can hardly afford to slow down fast, heavy main-line trains for track joint welding. Either a lookout must be used or possibly a warning device, as suggested by the Southern Pacific roadmaster. Perhaps *Railway Engineering and Maintenance* will give us full details of that arrangement in an early issue.

The first paragraph under Conclusions should be enlarged, framed and set on the desk in front of every maintenance officer and supervisor on every railroad in the country. Read it again!

Rail Failures, Their Cause, Detection, and Disposition

REPORT OF COMMITTEE

J. B. Martin
Chairman

SINCE the beginning of railroads in the United States and Canada, rail failures have presented a serious problem and have given rise to serious study on the part of both railroads and manufacturers, with the result that there has been a constant improvement in the quality of rails.

The original strap rails broke frequently, necessitating the maintenance of constant patrols to detect and repair defects. The strap rail was followed by various types of iron and steel cap tee-rails. Breakages were common, and even with the light equipment of that day speed restrictions of approximately 12 miles per hour were usual. The number of breakages were so high that some of the roads maintained shops for patching iron rails.

The introduction of Bessemer steel rails brought a great improvement. However, they developed many defects, due in some instances to faults of design or to the character of the maintenance, but generally to the character of the metal. As speeds and wheel loads increased, these defects developed more frequently. Fractures, pipes and split-heads were common and have usually been ascribed to impurities in the metal due to the limitations of the process.

About twenty-five years ago the railroads began to use open hearth steel rails, and they are now in general use on the principal main-track mileage. The metal is cleaner and produces a rail superior in many ways to those of Bessemer steel, being comparatively free from the defects that were common to the Bessemer rails, although it is prone to the more frequent development of the troublesome interior fissures. In the meantime, there have been improvements in design and a general increase in the weight of section, so that nearly all important main tracks are now laid with rail weighing from 90 to 152 lb. per yd. It is due in no small part to the quality of the rails that the present-day traffic, with its high speed and heavy wheel loads, is carried with such a high degree of safety.

Railroads are taking an increasing interest in research work and no work of this character is of greater importance than the investigation now being sponsored by the railroads and steel makers through the agency of the American Railway Engineering Association into the causes of rail failures and methods for improving the quality of rails. In their efforts to obtain better rail, the railroads have placed approximately 650,000 tons of intermediate manganese rail in the main tracks of various lines since 1924. This rail is 10 to 15 points lower in carbon content, and the manganese has been raised from a range of 0.70 to 1.00 per cent up to a range of 1.30 to 1.60 per cent. This produces a cleaner metal and the rail gives promise of greater resistance to wear. It is hoped, also, that the number of transverse fissures will be reduced, but there are indications of an increase in the number of horizontal and vertical split heads, particularly in certain heats. However, the service period has been too short to warrant definite conclusions at this time. The manufacturers and the railroads are also co-operating in tests with various alloys, heat treatment, etc., with the object of developing a rail possessing wear resistance, longer life, and a minimum predisposition to failure.

Importance of Rail Failures

The question of rail failures is important from an economic standpoint. A mile of new rail applied in one of the heavier traffic lines calls for an outlay of material and labor of approximately $15,000 to $18,000. To justify this expenditure, every rail must give its best life. It is a matter of no small importance, therefore, that in

1931, it is estimated that approximately 22,000 tons of rail was required to replace defective and failed rails, which in itself is a large item of expense. The maintenance of way department is also vitally interested in rail failures from the standpoint of efficiency in preventing failures and locating defects. This is a matter of education, organization and co-operation.

What has been done toward detecting and removing defective rails from track? Accident statistics of the Interstate Commerce Commission show a reduction of more than 60 per cent since 1923, in the number of accidents in which rails were involved. A. R. E. A. statistics do not indicate any marked reduction in the number of rail failures for that period and there has been a constant increase in the number of transverse fissured rails. For the year ending December 31, 1931, there were 770 more such rails removed from track than during the 11-month period ending December 31, 1930. However, there was a large increase in the number of rails in which defects were detected before actual failure, 2,686 in 1931 against 1,454 in the preceding 11-month period of 1930, and a corresponding decrease in the number of actual failures in tracks. Statistics for the calendar year of 1931 indicate that the number of defective rails found in the United States and Canada was approximately as follows:

Transverse and compound fissure rails 10,228, of which 5,433 were removed before failure.

Other types of defects 27,577, of which at least 17,577 were removed before failure.

These figures undoubtedly represent an understatement of the number of defective rails, as the statistics do not cover much of the older rail.

This is rather conclusive proof that the managements and the maintenance of way departments are alive to the importance of detecting rails that may fail; that important progress has been made and the best available methods and equipment are employed, and maintenance of way men should now give serious consideration to any other measures that can be taken to detect rails with defects before they fail. However, before further progress can be made, it is necessary to have a thorough knowledge of the different types of defects, their causes, and how to identify them.

Classifications of Failures

Rail failures have been classified by common usage under certain distinct headings. Defective rails can be divided into two great classes: viz., those defective because of internal transverse fissures, and those defective because of some condition affecting the head and termed head-failed rails. Web failures and base failures, the third and fourth classes, are negligible.

A distinction should perhaps be made between rails which fail due to faulty metal or poor workmanship in their manufacture and rails which fail in service because of damage sustained in handling or laying, or from faulty equipment passing over them, etc., but no such distinction is made in this report.

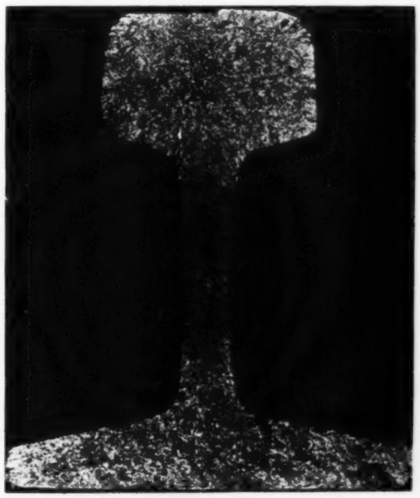
Battered Rail Ends—These are caused by differences in the height of rails at the joint, by loose bolts and ties, improper expansion, poor ballast, chipping of the ends of rails due to flowing of metal, and worn or improper fastenings (nut locks, bolts, and splices). This batter is largely a matter of maintenance and can be prevented or remedied by the following:

(A) Building up the rail ends in track by welding.
(B) The elimination of batter in track by thermit and seam welding in joint.
(C) Removal of the rail from track and cropping the ends.
(D) Removal of foul ballast and its replacement with clean material.
(E) Improved drainage.
(F) Care in finishing the rail ends at the mill.
(G) Careful rail laying and track surfacing.

One of the greatest items of expense in connection with misfit rails is encountered in their use with frogs and switches. Frogs and switches are made from new, or at least full section, rail, and when used against head-worn rail, batter and unusual wear and damage to the frog and switch material are immediately set up, resulting in short life for this expensive material and excessive maintenance costs.

Joint Gap Batter—Joints which do not have sufficient gap to permit rail expansion develop a chipping or upsetting of the top edge of the rail when the rail becomes tight. These chips and the upsetting usually start batter.

Flowing of Top Metal—All of the rails of more recent manufacture show a tendency for the top metal to flow over the rail end under traffic, until the top surface has hardened from cold rolling. These metal fins are frequently rolled into the top surface of the adjoining rail, causing indentations, and these fins eventually



A Clear Break

A Crushed Head

break off, leaving a chip in the original rail. These chips or indentations offer an irregular surface to the wheels and result in the starting of batter.

To eliminate this condition, the metal fins have been filed, or cut off in some instances with a hack saw, in track. However, with the cold-rolled and worked metal this has not been a satisfactory operation, and it has proved better to cross-grind the joint, giving the adjoining edges of the two rails a slight bevel. Some authorities advocate the beveling of the top edge of the ball of new rail before it is laid, to provide room for the flow of the top metal. Some roads have adopted the practice of beveling the rail ends and heat treating them when the rail is laid. Experience indicates that this will eliminate the chipping and retard batter, and is worthy of serious consideration. In the last few years marked improvements have been made in equipment and methods of doing this work.

The subject of rail batter has been covered thoroughly in previous reports, but it is generally agreed to be an important one and merits the serious attention of everyone. It causes rough riding track and increases maintenance costs materially through the necessity for larger expenditures for labor in surfacing, and damage to ties and other material.

Broken Bases—The half-moon fractures in the base originate in longitudinal base seams and occur principally in thin base rails (which have been largely eliminated in sections now in general use). Their development is brought about also by poor adzing, inaccurate cant, the presence of tie plate shoulders under the base, or damage in unloading, handling, and spiking.

Burned Rails—These are caused by the slipping of engine driver or booster wheels, and many tons of rail are ruined for main-track use annually in this way. They may be found anywhere, but they are usually to be found on grades, near the ends of passing tracks, at signals, at water stations, in the vicinity of passenger stations, and at other points where trains have occasion to stop or slow down. They cause bad riding track, and due to the heat set up in the rail by the slipping wheel the structure of the metal may be changed to such an extent as to result in a fracture. There has been a considerable increase in the number of such rails in the last few years, due partly to the increased tonnage of freight trains, and the remedy can be found in the co-operation of the different departments in the education of enginemen to avoid unnecessary slipping of drivers.

Split Webs—This type may be due to web seams, flaws or other defects, or a blow from a spike or maul or other tool delivered against the web of the rail, usually when moving the rail in gaging. The defect can often be found by close visual inspection.

Clear Breaks—This type of failure may be due to the composition of the metal, and is induced by such conditions as loose ties, loose bolts, worn angle bars, lack of ballast, or too light a section for the traffic, and can often be corrected by proper maintenance. Where the section is light for the traffic particular attention should be given to the condition of the ties, ballast and surface, and careful consideration should be given to proper speed restrictions. Failures of this class may be caused by such defective equipment as flat wheels or improper counterbalancing of locomotive drive wheels. This calls for co-operation in the detection and removal of defective equipment from service.

Split Heads—This type of defect originates in defective metal under the bearing surface. A longitudinal wedge is formed which splits the metal downward and lengthwise of the head. Evidence of its development is indicated by a dark streak near the center of the top of the head, a hollowing out of the top of the head, widening of the head, and sometimes a crack may be found directly beneath the place where the head joins the web. Rust under the head or rust streaks running down the web may be indications of the defect.

While this type of defect invariably gives some evidence of its presence before failure and it can be detected by visual inspection, it is one of the most serious, as the failure of a rail from this type of defect may cause difficulty. Sometimes the visible evidences are so slight that they are overlooked, and there is a tendency on the part of trackmen to leave such rails in the track and watch the development of the defect when, as a matter of fact, it may be more extensive and further developed than appearances indicate. This practice is wrong. The rails should be removed from main tracks as soon as discovered, as the defect grows rapidly.

Head Checks—This defect occurs principally in rails on curves on heavy grades. It has the appearance of a small perpendicular fissure which develops in the upper inside corner of the rail head. The cracks are apparently caused by the tractive force of the driving wheels, when ascending the grade, pulling the surface metal of the rail head in the direction opposite to the movement of the train. This develops small cracks crosswise of the rail, making the edges of the rail look like a mass of thin sheets of metal set side by side like a cross-section of the leaves in a book. This type of defect, while not general or numerous, is probably second in importance to the transverse fissures, from the standpoint of liability of failure.

Crushed Heads—This type of defect is detected most frequently by a crack running lengthwise on the side of the head and may be seen on either side, or on both. Sometimes the head for practically the entire length of the rail is involved, and the upper portion may be detached. This defect is similar to a compound fissure, except that it lies entirely in a horizontal plane. It is frequently evidenced by appearances similar to a burned spot.

An Example of a "Head Checked" Rail

Compound Fissures—This type of head defect starts lengthwise of the head about one-half inch below the surface and rounds off into a transverse section where it is generally dark and shell-like in appearance. Sometimes the top of the head comes off or can be pried up. Its other characteristics are similar to those of the transverse fissure.

Internal Transverse Fissures—This type of head defect has a granular center with a smooth surrounding surface which may be silvery or dark in color. This defect first came to notice in 1911 in the investigation of a passenger train wreck caused by a broken 90-lb. open hearth rail; the defect was classified at that time as a transverse fissure by the late James E. Howard, engineer-physicist for the Bureau of Safety, Interstate Commerce Commission; since then it has been the subject of wider discussion and study than any other type of rail defect. Since 1911 and up to December 31, 1931, the A. R. E. A. had record of an accumulated total of 58,227 rail failures due to transverse fissures, 7,481 of which occurred during the year ending with the latter date and 2,686 of which were detected before actual failure in track.

Without question, this is the most serious type of defect found in steel rails, for usually there is no warning of its presence prior to the failure of the rail, although occasionally it may come through to the surface in the shape of a fine hair-line crack on the gage side, but generally so fine and appearing on the under side of the head, that it is not easily discovered by the ordinary visual inspection. Experience shows that a percentage of the affected rails are multi-fissured and sometimes fail at several places at the same time. The fissure starts from a small granular nucleus growing outward. The rate of growth is very rapid in some

instances. Fissures are found in very young as well as very old rails. Traffic is a very important factor in the development of fissures, and for that reason some roads or sections of road that have light traffic do not experience as many fissured rails as other locations where traffic is denser.

Various theories have been advanced as to the cause of fissures, such as gagging, rate of cooling, and other mill practices, and over-stressing of the metal by the passing wheel loads, but there is no general agreement as to the definite cause.

The Detection of Defective Rails

The outstanding agency for the detection of defective rails has been the detector car, developed by the late Elmer Sperry. The first of these cars was put into operation in 1928, and a number of cars of improved design have been built subsequently. These cars have been operated over a large mileage to explore the rails for defects. This has resulted in the detection of many flaws, 90 per cent of which were invisible to surface inspection.

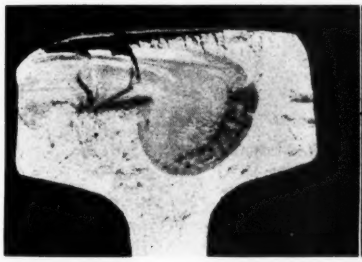
The operation of the detector is based on the theory that when a heavy electric current flows through a rail and meets some obstruction, such as a transverse fissure, the magnetic field is considerably distorted. The impulse set up in an ingenious detecting device by the distortion, when amplified, is made to produce a record on a paper ribbon or tape. In practice, this requires that the detector car be equipped with a generator to supply the direct current for energizing the rail. Brushes bearing on the rails, and held down by air pressure, transmit the current to the rail, a length of about four feet of rail on each side of the track being energized as the car moves along. Midway between these brushes is the detector. Wires leading from it carry the small impulses caused by the defects in the rail to an amplification set, and later through relays to a recording device which is arranged to give a clear record of the track tested on a paper ribbon. The location of the joints, and a land-mark line on which mile posts and other identification marks are shown, provide for a definite locating of the rails in track. In the circuit with the recording unit there is also a paint gun which squirts a daub of paint on the rail where defects have activated the circuit. The detector car is propelled by a gasoline motor of sufficient capacity to maintain a uniform testing speed of about six miles an hour.

The results obtained with a detector car vary widely on different roads and in fact on the same road, for, as previously stated, traffic is an important factor in the development of defects. In general, records of a large number of rails tested on many roads throughout the United States indicate that for every hundred miles of important track there may be expected 8 transverse fissured rails, 23 crushed head rails, 1 compound fissured rail, and 20 other defective rails. Statistics indicate that of all faulty rails encountered, about 24 per cent are defective because of transverse and compound fissures, 36 per cent because of crushed heads, and the balance due to split heads, cracked webs, etc.

In spite of all the benefits that have and will accrue from the use of detector cars, it is evident that there will be many miles of track that will not be covered by it, and even with its most intensive use, considerable periods will elapse between times of inspection. As can be seen from the foregoing paragraph, some of these defects develop very rapidly and it is still necessary for all track men to exercise eternal vigilance.

A Close Watch Must Be Kept

The section foremen, track walkers, and track laborers are the men who spend all of their time on the track and have the most intimate knowledge of the daily conditions, and they with their visual inspection and with such aids as can be given them must be depended on to discover the rails that are developing defects. It is a great tribute to their keen observation, devotion to duty, and sense of responsibility that they are finding and removing so many. However, in some instances it has been found that the track forces were not familiar with the various types of defects, or acquainted with their characteristics, and were thus unable to recognize them or the evidence of their existence, particularly in the early stages. Not knowing what to look for, or how to identify them, they were liable to ignore rails that had pronounced defects.


A Compound Fissure


A Split Head


A Horizontal Fissure

All field forces should be thoroughly educated as to the various types of defects and know how to identify them in the earliest stages and be trained to keep a sharp lookout for them at all times. This cannot be accomplished by written instruction alone, but must be supplemented by concrete examples; and supervising officers should make periodical checks to insure that the track forces are thoroughly familiar with all types of defects, know how to recognize them, are keeping a sharp lookout at all times, and know what action to take when defective rails are found. This education and training should be as thorough as in any branch of the work that affects operation. It should be a subject for discussion at meetings, and between foremen and supervisors on the ground; it is good practice to discuss each rail failure with the foreman on whose section it has occurred.

Some roads require periodical "knee" inspections. These are efficient and cost from $10 to $15 per track-mile. A very good aid in visual inspection is a special mirror device. This consists of a single mirror attached to a handle, or two mirrors, 14 in. by 6 in., attached to a light metal frame mounted on two small wheels to run on top of the rail with a 42-in. handle and a lever for regulating the angle of the mirrors and to spread

them in passing over joints. The mirrors are set at an angle to show the sides and undersides of the head, the fillets, and the upper portion of the web. Statistics indicate that approximately 10 per cent of the fissures extend to the surface, usually to the underside of the head, before the rail fails. These fine hair cracks are ordinarily difficult to see, and as other defects often show on the under side of the head, the mirrors are a considerable aid in finding defects that otherwise would be overlooked. This inspection costs from $1.25 to $1.50 per track-mile. Rails in platforms, crossings and other places where they are largely covered and hidden from view should be thoroughly cleaned and examined whenever repairs are being made.

Disposition of Failed Rails

Occasional Battered Rail End—If the surface of such a rail cannot be built up satisfactorily by welding, it should be removed and the battered portion cut off to permit reuse of the rail.

Broken Bases—Rails with broken bases should be removed from main tracks on discovery and may be reused only in sidings and yards. If such use is rather intensive the broken base should be reinforced with angle bars.

Burned Rails—Badly burned rails should be removed from main track and may be reused in sidings and yards.

Split Webs—Rails with this defect should be removed from main tracks when discovered and the sound portions of the rail, if of sufficient length, may be cut out and reused in minor tracks.

Clear Breaks—Such fractured rails should be removed from track immediately upon discovery, and traffic handled as outlined under fissured rails. These rails may be used in minor tracks where the speed is low, if of sufficient length.

Split Heads—Rails with this type of defect should be removed from track immediately on discovery and should not be permitted to remain in track pending further development of the defect.

Fissured Rails—All fissured or head-checked rails, whether fractured or not, should be removed from the track immediately. Owing to the uncertainty as to the number of fissures in the individual rail, rails with transverse or compound fissures, or any fractured rail, should be removed before the passage of trains is permitted, and in no case should trains be permitted to pass except at slow speed. Fissured rail removed from track should be scrapped and must not be used again for any purpose where the track structure is involved. They must be distinctly marked or broken into short lengths so there will be no chance of mistaking them for usable rails.

Inasmuch as fissures are the most serious type of defect, many roads make it a practice to remove all rails of any heat after a certain number of fissure failures occur in it, and it is recommended that all rails of any heat be removed from important main tracks after three fissure failures, or from minor main tracks after five fissure failures, except that before deciding to remove the heats, consideration should be given to the signal protection, speed, character of roadbed and traffic, and the nature and frequency of the rail inspection. Rails that are removed must not be used again in main tracks or used in the manufacture of frog and switch material.

Where rails are being removed because of detector-car operation, either new rails, or relayer rails which have been tested within a specified and limited time before their removal, should be used for replacements. When new rails are being laid, all of the old rails released which are of a known transverse fissure heat should be marked and not reused in main tracks or for manufacturing purposes. When one transverse fissure failure occurs in a heat, all rails of the heat should be given a distinguishing mark and track men must give such rails special attention. To facilitate this, it is recommended that rails be segregated by heats in laying whenever this is practicable, and a record kept of the location so that all rails of any particular heat can be readily located when desired.

Statistics over a considerable period of years show that the greatest number of failures occur in the "A" rails, and it is recommended that the "A" rails be segregated in laying, preferably at slow speed points and on tangents. It is the practice on some roads to report all rails that fail before a certain age to the manufacturer, who then arranges for their inspection. This is commendable practice, as, no matter what the outcome of the inspection may be, the knowledge gained is valuable to both manufacturer and railroad.

A Transverse Fissure that Has Extended to the Surface

Conclusions

In conclusion it is recommended:

(1) That railroads, manufacturers, scientific bodies, engineering associations and laboratories continue to co-operate in research into the causes of rail failures, with a view of eliminating the defects and producing a stronger and more wear-resisting rail.

(2) That every effort be made and all means used to discover and remove defective rails from track before failure, and that particular attention be given to the education and training of the field forces in this matter.

(3) That all rails of a particular heat be removed from main tracks after a specified number of transverse fissure failures, except as modified in preceding paragraphs, and that these rails be not reused in main tracks or for manufacturing purposes.

(4) That released rails of a heat known to contain fissures be restricted in use as outlined in preceding paragraphs, regardless of the number of failures.

(5) That after one transverse fissure failure occurs in a heat all rails of that heat should be marked in track and given special attention.

(6) That rails of the same heat be laid together and a record kept of their location.

(7) That "A" rails be segregated and laid together at points of slow speed and on tangents.

(8) That all defective or failed rails be disposed of as outlined in this report.

(9) The careful handling of all rail, the employment of the best and most careful methods of laying, and the care of rail to avoid damage.

Committee: J. B. Martin, (chairman), general inspector track, N. Y. C., Cleveland, Ohio; E. L. Banion, roadmaster, A. T. & S. F., Independence, Kan.; A. J. Bolsins, roadmaster, S. P., Edinburg, Tex.; C. A. Chamberlain, roadmaster, L. A. & S. L., Milford, Utah; H. R. Clarke, engineer maintenance of way, C. B. & Q., Chicago; J. P. Corcoran, supervisor, Alton, Bloomington, Ill.; F. W. Easton, roadmaster, S. P., Ogden, Utah; W. O. Frame, district engineer maintenance of way, C. B. & Q., Burlington, Iowa; N. M. Gamble, supervisor, Wab., Peru, Ind.; L. W. Johnson, roadmaster, M. P., Hoisington, Kan.; W. H. Jones, roadmaster, A. T. & S. F., Chillicothe, Ill.; Charles Kratoska, roadmaster, C. & N. W., Ames, Iowa; F. B. Lafleur, roadmaster, S. P., Lafayette, La.; M. E. Loftus, roadmaster, M-K-T, Muskogee, Okla.; F. J. Meyer, assistant engineer, N. Y. O. & W., Middletown, N. Y.; A. E. Preble, supervisor, Penna., Reading, Pa.; I. H. Schram, engineer maintenance of way, Erie, Jersey City, N. J.; R. H. Smith, general superintendent, N. & W., Roanoke, Va.; G. L. Sitton, chief engineer maintenance of way and structures, Southern, Charlotte, N. C.; I. D. Talmadge, roadmaster, N. Y. O. & W., Middletown, N. Y.

Discussion

J. A. Snyder (roadmaster, M. C.): This is an excellent report, being very complete as to kinds of rail failures and methods of handling them. I do not feel competent to add anything to it, except to emphasize more fully two or three of the points that were mentioned by the committee. I think fissures, either compound or transverse, constitute the most dangerous of all rail failures and that rails containing these defects should be removed from the track as soon as they are detected. Without doubt, the best method yet devised for detecting such defects is the Sperry method. While split heads and crushed heads are not as dangerous as fissures, these rails should be removed from the track as soon as discovered.

Early this year a company-owned Sperry detector car was run in both directions over the double-track heavy-traffic division over which I have supervision. On the north bound track which carries the heavier traffic four fissures were found in 47 miles. The rails were removed from the track the same day the defects were discovered. A few days later the rails were broken and the fissures were found exactly where marked by the detector car operator. On the southbound track no fissures were found. Both tracks were laid with 105-lb. Dudley-section rail, applied in 1921, 1923, 1924 and 1925. The rail in both tracks was laid on good ties, with crushed rock ballast about one foot deep under the ties.

A class of rail failure which should receive increased attention, especially from the economic standpoint, is the battered or chipped end. If these rails are repaired by welding before the batter progresses too far, the life of the rail may be prolonged by several years. In August and September, 1931, 9½ miles of 105-lb. Dudley rail on my division was welded by the electric-arc method, and to date no rail has been removed from the track because of weld failure. This rail was laid in 1923 and ballasted with one foot of crushed rock ballast the same year. The splice bars were 36 in. long and were fastened with six 15/16-in. bolts. Before the welding was done, reformed 36-in., 6 bolt splice bars were applied and the joints were surfaced. While this work was done only two years ago, it shows up well and we are now welding several additional miles by the same method.

To acquaint section foremen with the various kinds of rail failures we have distributed placards, to be posted in tool houses, giving pictures and descriptions of fissures and other kinds of breaks for ready reference. I agree fully with the committee in its recommendations for the disposition of failed rails, and in its conclusions.

Armstrong Chinn (chief engineer, Alton): As aptly stated in the report, the high degree of safety of modern railroad traffic is due, in large measure, to the quality and soundness of the rails that carry it, for it is obvious that this traffic can be no safer than the foundation upon which it runs. This safety has been attained, not only by improvements in the art of manufacturing rails, but also by educational programs carried out in the maintenance of way departments of the railroads, aided by committee studies and reports such as we have here, that are designed to teach the man on the ground how to take care of rail, how to identify defective rails before failure and the importance of removing them from the track as soon as discovered. I have been impressed with the progress being made by trackmen, particularly supervisors and foremen, in their ability to detect defective rails. Most of us can remember when it was a rarity to find a division where the majority of the foremen realized the necessity of removing rails with such easily seen, progressive defects as split heads, pipes and horizontal fissures; whereas, at present, as a result of educational programs and committee work, I have records of several foremen who have become so proficient in spotting bad rails that they have discovered, before failure, the most difficult of all defects to find, transverse fissures that had worked out to the rail fillets.

The report points out the inestimable value of the detector car in locating defective rails. Designed primarily to locate concealed transverse fissures that could not be found otherwise, it works equally well in locating other types of defects. Its primary value is, of course, the locating of defective rails, but it has a secondary value in that it helps to teach the trackmen who accompany it how to locate rails with visible defects, and these men are not going to be chagrined when the car comes to them a second time by having it find rails with defects that they themselves should have found.

As a result of educational programs, supported by committee reports that gather and condense available information, and the operation of detector cars, I am confident that the tracks of American railroads are freer from defective rails today than ever before.

What of the Chemistry of Rail Steel?

C. W. Baldridge (assistant engineer, A. T. & S. F.): In the third paragraph the report states that "Bessemer steel rails developed many defects, due in some instances to faults of design or to the character of maintenance, but generally to the character of the metal * * * * *. Fractures, pipes and split heads were common and have generally been ascribed to impurities in the metal due to the limitations of the process." Historical studies of the processes of rail making, during the days when Bessemer steel was used, show that the mill practices at that time, as compared with those now followed, are sufficient to account for all of the difference in the number of rail failures then and now. Attention is called particularly to the fact that the amount of metal discarded from the top of the ingots at that time was usually only three to four per cent of the ingot, while the top discard, which was agreed upon about the time that the use of open hearth steel for rail making became dominant, now amounts to approximately 12 per cent of the ingot.

Statistics collected by the American Railway Engineering Association have shown that as high as 52 per cent of all rail failures reported in a year, since the use of open hearth steel has become prevalent, have occurred

in the "A" rails. It becomes a fair question, therefore, to ask what percentage of rail failures used to occur in the rails made from that part of the ingot included in the zone between the old 4 per cent discard and the later 12 per cent discard.

Again in the days of Bessemer steel, the testing practice required one test to be made from each five heats, or melts, of steel, while we now require three tests from each heat as a minimum, and in many cases an every-ingot "nick and break" test in addition. Furthermore, the test specimen was selected from any part of the rail bar made from an ingot, which the mill pleased to take and, naturally, that meant the best part if possible. Present practice requires the test bar to be cut from the bottom end of the top discard. These and other conditions make it very doubtful whether the so-called impurities in the metal had anything to do with the larger number of rail failures. This does not mean that we should return to the Bessemer process of making rail steel, but it does mean that we should have open minds on the question of the chemistry of rail steel and should make careful studies and thorough tests of modern rails made to the chemistry which in the Bessemer steel gave us harder and stronger rails in proportion to size and design, and certainly better wearing rails than we have secured by recent practices.

Methods of Handling Snow and Ice on Railroads

Including Drainage of Switches and Other Track Structures Where Snow-Melting Devices Are Used

REPORT OF COMMITTEE

J. J. Davis
Chairman

ONE of the most perplexing problems of the maintenance of way departments of the railroads in the northern section of the United States and in Canada is that of keeping their tracks open for uninterrupted train service during severe snow and sleet storms. There seems to be a rather general impression that the snow storms of recent years are much less severe than those of thirty or forty years ago, yet records taken at various places do not substantiate that idea. The accompanying tabulation taken from the records of the weather bureau show the amount of snowfall in the worst storms of each year from 1891 to 1931, inclusive. The figures indicate the amount of snow for the entire duration of the storms, which, in some cases, covered two or three 24-hour periods. From this tabulation it is apparent that the amount of snow and the intensity of storms has, on the average, been fully as severe in recent years as formerly, and in Chicago the storms of 1930 and 1931 were the heaviest on record.

There have also been changes in the railroad industry, particularly as to speed, density of traffic, and standards of efficiency in train operation, which have increased the problem of keeping the railroads in continuous operation during these severe storms, compared with conditions 25 years ago. With the intense competition from other transportation agencies, and with the railroads endeavoring to build up and maintain a faster, better and more dependable transportation service, many developments have been made in the track structure, such as remote-control, power-operated switches, complicated and extensive interlocking plants, and car retarders in freight classification yards, all of which tend to increase the problem of combatting snow and sleet storms.

In meeting any problem in maintenance, by far the most important and yet most frequently neglected step is the *preparation* that is made for it. Severe storms often come without much warning and, at times, contrary to weather forecasts that are ordinarily reliable. Without adequate preparation and foresight in both organizing and equipping the snow-fighting forces, unusually heavy expense will be incurred by reason of the resulting low efficiency and the delays to train operation.

The committee, therefore, feels that the subject naturally divides itself into two parts, the most important being preparation which, if carried out properly and carefully, make the second part, that of handling snow storms—much more free from "grief" and trouble. Although to a certain extent some of methods employed are alike, it has also been thought best to consider the problem on main tracks separately from that in yards, terminals and station grounds.

Main Tracks Outside of Terminal Limits

A common but very effective protection against tie-up on main tracks is provided by snow barriers or snow fences, properly located at the correct spacing from the track, and of sufficient number, whether one, two or three lines, to make this protection effective. In many locations the right-of-way is not of sufficient width to obtain adequate protection against snow from permanent snow fences placed on the right-of-way line. However, most of the adjacent property owners—particularly through rural sections—will not object, if properly approached, to the placing of portable fences outside of the right-of-way during the snow season. Past experiences with the stalling of trains and the necessity of using snow plows in certain cuts, point definitely to the benefit to be gained from an additional line of portable fence, which if properly placed will pay great dividends on the cost of installation.

A canvass of 15 railroads has indicated the most economical and effective type of permanent snow fence to be the picket type indicated in the plan. If properly erected, it presents a neat appearance, compared with the common board fence and, over a period of years, considering the cost of both material and labor, should prove more economical to maintain. The most commonly used permanent snow fence is also shown, consisting of 1-in. by 6-in. boards nailed to fence posts. Some railroads depend upon shrub-type fences or hedges of such plantings as California privet, barberry, young cedars, rambler rose, etc. When properly maintained these lend beauty to the right of way and are very effective as snow barriers.

The most commonly used portable snow fence is of

the folding type which has been adopted by the American Railway Engineering Association as a recommended standard. The Illinois highway department has made use of the picket type fence as a portable snow fence and has reported very satisfactory results. Because of its ease of erection and greater life, it is said to be very economical. A regular program should be followed in repairing and renewing permanent fences and in placing the portable panels as soon prior to the snow season as conditions will permit. During severe storms the results attained with these fences should be observed carefully to determine if they have been properly placed and are functioning effectively. A clean right-of-way will be subject to less drifting and will accumulate less snow.

Prepare the Roadbed

This preparatory campaign should always include the cleaning of all surface ditches and the establishing of drains from switches to assure that water from melting snow will get away quickly before freezing and thus obviate the expensive picking necessary to clear ice from the movable switch points and the flangeways of frogs and guard rails. In practically all cases these provisions for drainage can be made in tracks outside of yards and terminals without much expense. The failure to make such preparations is commonly due to lack of foresight.

Amount of Snowfall in Heaviest Snow Storm of Each Year 1891 to 1931

Snowfall in inches and tenths

Year	New York	Montreal	Chicago	Minneapolis	Denver	Seattle
1891	7.6	9.3	5.5	....	18.0	No record
1892	12.7	15.9	6.2	4.0	6.2	No record
1893	17.8	9.5	8.7	8.5	8.9	No record
1894	15.0	11.0	10.8	6.5	10.7	7.0
1895	5.7	9.4	12.0	3.6	11.4	10.0
1896	9.5	16.8	12.5	5.0	7.5	17.8
1897	10.0	14.3	10.0	6.5	13.5	4.0
1898	8.8	16.9	6.5	9.0	15.5	12.0
1899	15.5	10.0	3.0	12.0	13.1	10.0
1900	10.9	18.2	11.3	7.0	7.8	2.8
1901	2.5	10.3	12.7	10.8	10.8	8.3
1902	9.3	4.9	3.0	2.7	6.4	9.2
1903	10.5	12.5	11.3	4.0	7.0	6.2
1904	7.8	9.3	8.7	6.0	7.0	4.0
1905	9.0	8.5	6.3	9.0	10.0	4.1
1906	7.0	9.0	3.4	9.0	22.7	3.8
1907	10.7	10.2	8.2	13.0	18.0	6.5
1908	10.2	17.4	12.8	10.8	12.5	2.0
1909	10.1	7.7	7.5	10.5	14.0	12.0
1910	14.6	9.8	10.6	6.0	8.0	3.9
1911	6.5	11.5	8.4	8.2	5.4	3.1
1912	11.8	10.7	6.4	8.5	14.2	2.5
1913	2.0	12.7	4.2	8.8	45.7	7.0
1914	14.5	9.7	9.5	4.0	6.4	0.7
1915	10.2	8.9	4.6	11.0	7.0	0.4
1916	12.0	8.5	4.7	5.1	4.5	33.4
1917	9.2	7.7	5.6	15.8	12.0	6.1
1918	5.9	10.2	14.9	10.9	12.0	5.0
1919	2.0	14.0	6.0	3.5	8.4	1.0
1920	*17.5	12.2	6.4	6.8	18.2	2.4
1921	12.5	5.0	2.4	4.2	10.0	5.0
1922	7.0	8.0	1.4	6.3	14.1	3.0
1923	8.5	5.2	3.0	8.9	13.5	17.4
1924	8.0	8.6	4.6	11.0	10.2	7.3
1925	10.0	9.2	3.9	3.5	7.8	Trace
1926	11.6	12.8	12.6	4.9	6.8	3.0
1927	5.0	9.0	9.5	6.3	8.5	2.1
1928	4.5	10.9	8.4	9.5	15.5	1.6
1929	7.2	6.8	14.7	5.7	16.2	9.9
1930	3.2	5.1	19.1	5.5	13.6	2.8
1931	2.8	9.7	16.2	5.0	12.0	Trace

*Includes 8.8 in. of sleet

In preparing switches for winter it is common practice on almost all railroads to clean out the ballast down to within an inch or two above the bottom of the ties from the switch points to just beyond the heel of the point, and also under the frog and guard rails. Too often, however, this work is heedlessly postponed until after some frost is encountered, making it much more expensive and sometimes resulting in failure to complete it before the first storm.

Arrangements should be made at least a month before the beginning of the snow season to check all the equipment provided for snow fighting. An adequate quantity of hand tools and supplies, such as snow brooms, snow shovels, picks, salt and melting chemicals, should be on hand and distributed to the various sections. The distribution of this equipment naturally must be governed to a great extent by past experience. Good snow tools are by far the cheapest, this being particularly true in regard to snow brooms.

All heavy and special equipment such as snow plows, flangers, spreaders, etc., should be carefully checked and tested to be sure that they are in readiness for immediate use. The proper number of tools such as snow shovels, brooms, picks, spike mauls, spikes, re-railing frogs, etc., should be placed on the plows.

Provision should be made as far as possible to insure good vision for snow-plow operation. Manually or air-operated window cleaners can be installed to keep front windows clear of snow on the outside and frost can be eliminated on the inside of windows by the use of celluloid anti-frost shields. It should be universal practice to have the lookout windows of all work equipment used during the winter season equipped with "frost glass." This consists of two or more panes of glass with an air space between them, tightly sealed to prevent air circulating between the panes. However, on such equipment as snow plows window cleaners and celluloid anti-frost shields should be added.

A careful inspection of the track should be made preparatory to the snow season to determine if all obstructions that do not provide proper clearance for the operation of snow plows are either removed or properly marked by suitable signs. It is recommended that where possible all private crossing planks and wing fences be removed, and it should be one of the duties of the track foreman to confer with the interested adjacent property owners to see if this can be done. In other words, every precaution should be taken to reduce to a minimum the hazards of operating snow plows.

One of the most important preparatory measures, while not so complicated on outlying sections but yet worthy of careful study, is the proper organization and instruction of the regular forces so that an increased force, amplified by the addition of inexperienced men, will be able to function safely and efficiently. It is usually possible to divide the regular forces so that the temporary employee will have the benefit of supervision by experienced men, and preparations made in advance for the assignment of responsibility according to such a plan will be very helpful in avoiding confusion when the emergency arises. *A plan which may be carried out in part is better than no plan at all.*

A broom and shovel should be fastened to a post set near the switch stand on outlying switches for the use of train crews, as the availability of these tools will not infrequently save delays during severe storms.

An inspection should be made to see that adjustments on interlocking switches and derails are not set up tighter than is necessary. Adjustments made with this in mind, while maintained within a safe tolerance, will lend to preclude delays often occasioned by the tying up of the plant because of a small film of ice or snow. Careful preparation for good drainage around pipe lines, equalizers, switches and derails at interlocking plants is even more important.

Yards, Terminals and Station Grounds

It is of especial importance that adequate preparation be made for winter storm conditions in yards, terminals and station grounds. Ballast should be cleaned out between the ties at switch points, frogs and guard rails, and the switching leads should be so graded that good surface drainage is secured. Drainage is important at all locations in disposing of water from melting snow, but

is of extreme importance where snow melting devices are used. The installation of these devices should not be made without first providing suitable drainage. There may be certain conditions which prohibit the practicability of providing surface drainage from certain switches, and in these cases sub-surface drains should be installed.

There may be cases where the installation of sub-surface drains is not feasible or where the expenditure is not warranted and in such locations a blind drain can sometimes be installed somewhat as follows: Dig a hole about 4 ft. in diameter and about 6 ft. deep and place in the bottom of this hole 6-in. to 8-in. cobble stones, large pieces of coke or other material of this character to a depth of about 2 ft. Place a 12-in. vitrified sewer tile, 4 ft. long in the center of the hole with the bell end up and with an iron grating inserted in the top at an elevation that will insure drainage from the switch. Then back-fill the pit with large stones It will be found that such a pit, which should last for three or four years, will handle a considerable amount of water.

The proper grading of yard body tracks to secure good surface drainage will warrant considerable expenditure, particularly in gravity switching yards where a considerable depth of water might accumulate during midwinter or early spring thaws, and if accompanied by a quick drop in temperature might bring rather disastrous results. Yard tracks should be so constructed that each succeeding track will be about two inches lower than the preceding track, and subsurface drains should be installed at the low point to take care of the run-off.

Conditioning of Equipment

All the equipment on hand or available for use in handling snow in yards should be checked over and placed in proper condition at least a month prior to the snow season. Material and small tools, such as brooms, salt, picks and shovels should be drawn from the storehouse and distributed prior to the arrival of winter so that the assembling of this equipment will not need to be done after a storm arrives. A supply of salt should be conveniently stored and suitable receptacles should be provided for handling it. These are small details but ordinarily they are the ones most frequently overlooked, and failure to arrange for them will result in confusion when the emergency arises.

Gas, electric, oil burning, or other types of switch heaters should be connected up and tested thoroughly to discover and repair any defects or replace worn-out parts. Blow torches, weed-burning machines and other equipment of this nature should be tested and a supply of fuel for their operation should be stored at convenient locations. Steam jets placed under the leading footboard of yard engines are very effective in cleaning slip switches and leads, and should be installed and tested well in advance.

Co-operation of Forces

The organization of the regular forces is the most important preparation which can be made, this being particularly true in large yards or terminals. Familiarity with the problems of the operating department is essential and can be best acquired by a discussion of the requirements with yardmasters or other supervisory operating officers. Without this understanding, unnecessary or wasted effort may be expended at unimportant locations at a time when an insufficient force is attempting to avoid tie-ups at key locations. In very severe storms it is often more economical to make some changes in the ordinary operating moves, resulting possibly in the temporary abandoning of some of the less active tracks or switches and concentrating forces at strategic points. If such co-operation can be secured far better efficiency will result.

In selecting men to supervise inexperienced emergency forces and to take active charge of certain assignments, foremen should choose from their gangs men who are experienced and otherwise best qualified for such work. The manner in which they handle this responsibility affords the foreman and supervisor knowledge of their ability to accept promotion when the opportunity subsequently occurs. Plans should take into consideration the alternate relief of experienced men in case of storms of long duration in order that there will always be such men on hand to supervise and direct inexperienced men, especially at night.

Detailed Instructions for Congested Terminals

In terminals subject to serious traffic congestion it is sometimes the practice to evolve elaborate detailed instructions covering the assignment of all of the forces which can be drawn into service during storms. These instructions are printed and distributed so that all of the men to be called have a regular routine to follow, being either definitely assigned to some particular location or instructed to report at some local point for distribution as found necessary at the time of their arrival. The location of the various units is shown on these printed forms, as well as the telephone numbers and home addresses. The foremen in the various departments whose men are on call are instructed to call specified supervisors or assistant supervisors as soon as the severity of the storm indicates the need for more help. The men are then definitely assigned and notified where and when to report. In these assignments the bridge and building, water supply and signal department forces and such men in the engineering department as are familiar with the railroad are drawn into service and assigned to duties or locations in accordance with their particular qualifications, the most experienced men naturally being delegated to the key positions. Division and local meetings of the supervisory officers of the operating and maintenance of way departments are held just prior to the snow season for a discussion of the ways and means of handling snow storms and to perfect a program in as much detail as possible covering the assignment of forces.

Men Must Be Fed

Arrangements should be made in advance for lunches for those men who are kept in service for long periods and cannot go home for meals. This is ordinarily the case in large yards and terminals where emergency forces must be recruited without allowing the men time to bring lunches. Agreements can usually be made with local restaurants to provide meals or furnish lunches and coffee, the timekeepers or foremen securing receipts or issuing identification cards in order to provide means of checking the expense. Some railroads make use of the dining cars on wrecking outfits, and others maintain commissary cars where sandwiches and coffee are supplied This is an important provision to make and amply justifies the expense because it assists in maintaining the morale of the men when they are kept in service on long assignments.

It is the experience of some railroads that the responsibility for keeping turntables, enginehouse tracks,

cinder pits, and other facilities around engine terminals, coach yards, repair tracks and roadways free of snow and ice can best be placed with the mechanical department. These forces are thoroughly familiar with the requirements and if the responsibility is definitely assigned to them by the management, less confusion, inefficiency and shifting of responsibility results when delays are occasioned in this department. The committee recommends that this practice be adopted as far as possible. This can be extended in some degree to l. c. l. platforms, station platforms, etc., where the responsibility can be delegated to the supervisory forces of the using department and use made of freight handlers and other station employees who might be idle pending the switching of cars, augmented when necessary, by emergency help. It is exceedingly simple and sometimes convenient to be able to place the blame for delays with some other department in case of severe storms, and if responsibility can be placed with the department affected both as to expense and delays, much better results will be attained.

"Safety is of the first importance in the discharge of duty" is a phrase appearing in all standard operating rules and should be particularly emphasized when instructing and educating the regular employees who will form the backbone of the snow-fighting organization. Special bulletins posted just prior to the snow season are helpful in calling the attention of the men to the particular hazards incident to this work. They should be urged to look out for the safety of the inexperienced men who are called into service and to direct their attention to any methods which they know to be dangerous.

The most frequent cause of failures in handling snow storms is the failure to get the organization on the ground and at work in time. Serious delays are sometimes encountered before the men and equipment can be assembled, particularly when storms break with great intensity. At the first indication of a storm, steps should be taken to see that men can be recruited on short notice; in fact, it is better to have a few more men on hand at the start of the storm than to have none available. If this plan is followed the nucleus of the organization will have an opportunity to assimilate the larger force immediately if the storm becomes severe.

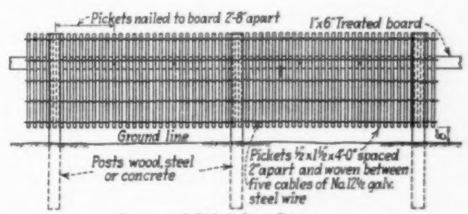
Even under the most favorable conditions, serious hazards attend the fighting of snow storms by hand methods in busy yards or terminals. Vision is obscured, and the high winds and low temperatures that usually accompany the more severe storms make hearing difficult. This condition is aggravated in electrified zones by the quiet operation of the trains. In such cases a lookout must be placed beyond each end of a gang, and especial discrimination in selecting men for this important duty should be used.

Advantages of Switch Heaters

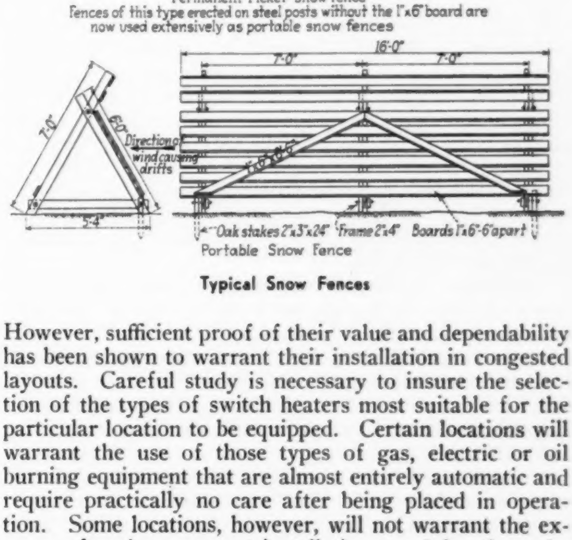
Aside from the clearly demonstrated economy of switch heaters in congested interlocking territory, they possess a particular advantage in obviating manual work of a highly hazardous nature. The complicated switch layouts in interlocking plants, some parts of which are located quite a distance from the controlling towers, are extremely hard to keep clear by hand methods during a bad blizzard. The committee feels that all such congested layouts should be equipped with switch heaters which require little or no attention after they have been once placed in service. A sufficient number of installations of the various types of switch heaters have seen service in and around Chicago and New York in bad storms to demonstrate clearly their value and dependability. Among installations made in Chicago are those at the La Salle Street station and the Union Station, on the Chicago & North Western at four of its busy interlocking plants in and approaching the passenger terminal, and on the Chicago, Milwaukee, St. Paul & Pacific at the busy layout at Western avenue and Kinzie street. These installations have proved very efficient and have resulted in large savings as compared with the hand methods used prior to their installation. The severe blizzard of March, 1931, provided a very good test of the appliances and demonstrated their value conclusively. Trains were operated in and out through these congested locations without delay, a feat which would have been impossible by hand methods.

Many Appliances for Melting Snow

A large variety of appliances are available for use in melting snow, many of which have been tested and found dependable during the storms of recent years; others are undergoing improvements designed to correct defects that developed in their use. It is true, of course, that the operation of these heaters has not been tested under the most extreme conditions of cold, wind and snow.



Permanent Picket Snow Fence
Fences of this type erected on steel posts without the 1"x6" board are now used extensively as portable snow fences



Portable Snow Fence

Typical Snow Fences

However, sufficient proof of their value and dependability has been shown to warrant their installation in congested layouts. Careful study is necessary to insure the selection of the types of switch heaters most suitable for the particular location to be equipped. Certain locations will warrant the use of those types of gas, electric or oil burning equipment that are almost entirely automatic and require practically no care after being placed in operation. Some locations, however, will not warrant the expense of such permanent installations, and for these the use of portable burners is advisable. Still less important locations are more economically handled by manual methods, and for that reason the snow shovel and snow broom will probably never be entirely displaced for keeping switches cleaned.

Busy slip switches or simple turnouts outside of interlocking territory can be kept open effectively by use of portable oil-burning pots of demonstrated merit. From 8 to 16 of these pots are required for a simple turnout and from 40 to 50 at slip switches. The most successful operation of these pots is insured if they are not placed in the track until conditions indicate that they will be

needed. This is recommended because experience shows that they are likely to become clogged with cinders or ballast if they are set in position too long beforehand and they will not then work to the best advantage when storm conditions are at the worst. They should be conveniently stored and placed in first-class condition ready for immediate use, and if this is done they will give very good service.

Melting Snow With Yard Engines

An effective method of cleaning slip switches, important turnouts and busy leads is to use yard engines equipped with perforated pipes mounted under or back of the leading footboard and connected to the steam dome of the locomotive. The valve at the steam dome is operated by hand as required. The intense heat and high pressure of this steam jet melts and blows the snow and water clear of the switch. It is advisable, however, to have one or more men follow up back of the blower to clean cinders or other ballast from the slide plates of switches and movable-point frogs. By operating this engine slowly through a slip switch it can be completely cleaned in about five minutes, leaving no accumulation of water to freeze except the moisture left on the rails and ties. An entire lead can be cleaned very quickly in this manner, and while it is necessary to stop operation on this lead while the steam jet is in use, it will result in the end in less delay than hand methods and leave the switches absolutely clean. The chief objection to the use of this method is the obstruction to vision caused by the cloud of steam on adjacent leads when the wind is in the direction that will carry it across the yard.

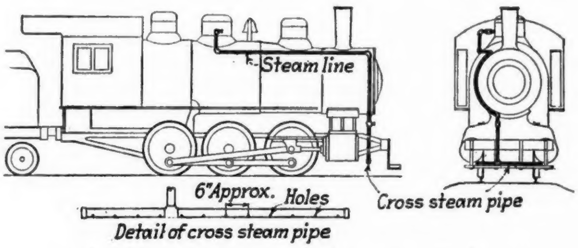
Railroads having weed burners as a part of their maintenance equipment have found them very effective in melting snow particularly where car retarders are in use. It is very difficult to clean these car retarders by hand methods and these weed burners have proved very successful.

With the constantly increasing distribution of electric power, and manufactured and natural gas, and the great improvements being made in the use of oil burners, the committee recommends that all of the more important and busy track layouts be studied with the thought of replacing hand methods of clearing snow with the type of switch heater most readily and economically suited to the location in question.

Caterpillar cranes and locomotive cranes have been found effective in loading snow where this is required and considerable use is being made of trucks in hauling snow from station platforms, team tracks and (where they can have access) to leads in yards. Large accumulations of snow at station platforms have been disposed of economically by constructing a large vat close to a drain outlet and blowing steam into the vat through three or four vents. The snow is melted very rapidly and the water is carried away by the drain. Such an installation would, of course, be practical only when suitable space and drainage facilities are readily available.

Snow-Loading Machines

Snow-loading machines, self propelled and mounted on railway wheels, have proved successful where a large accumulation of snow ordinarily occurs. In the use of these machines, the snow is plowed with a Jordan spreader onto one track to a depth of four or five feet. Empty cars of the most convenient type available are set on the adjoining track, and these machines, which are of the continuous conveyor design, are propelled along the track on which the snow has been piled and load the cars alongside through the use of well arranged chutes. The machines now in use load snow from a width of about ten feet and travel at a rate from two to five miles per hour, depending on the depth and condition of the snow. Among the difficulties so far experienced with these machines has been the damage done to cutting knives and gears occasioned by the picking up of car scrap, such as knuckles, brake rigging, etc., which is hidden in the snow. There has also been some difficulty in getting sufficient traction on the driving wheels to propel the machine. A machine recently developed in Canada is modeled somewhat after the rotary snow plow. The snow is picked up by heavy auger-type knives and delivered to a powerful rotary blower that forces the snow



A Switch Engine Equipped to Blow Snow with Steam

through a chute and into the cars. This machine operates over a width of about ten feet and is faster than the conveyor type, but has not been in use long enough to work out the difficulties which would be encountered in railroad use.

In fighting snow as in all other phases of maintenance work, the machine and labor-saving appliances are replacing hand methods and, in practically all cases, are doing a better job. This means, however, that more skill, a better-trained organization and a more carefully worked out plan are required. The snow broom and snow shovel will always be the backbone of the snow fighting equipment, but with constantly decreasing use and importance.

Committee: J. J. Davis, (chairman), supervisor, Elgin, Joliet & Eastern, Joliet, Ill.; C. A. Geiger, supervisor track, New York Central, Columbus, Ohio; R. S. Gutelius, general roadmaster, Delaware & Hudson, Carbondale, Pa.; C. M. Hayes, assistant general roadmaster, Soo Line, Minneapolis, Minn.; F. Ivers, Jr., roadmaster, Oregon Short Line, Cache Junction, Utah; Paul F. Muller, roadmaster, Chicago & Western Indiana, Chicago; J. A. S. Redfield, assistant engineer maintenance, Chicago & North Western, Chicago; T. Thompson, roadmaster, Atchison, Topeka & Sante Fe, Joliet, Ill.; F. Tranzow, superintendent track, Grand Trunk Western, Detroit, Mich.

Discussion

R. L. Sims (district maintenance engineer, C. B. & Q.): Locations where permanent snow fences are to be built should be considered carefully before undertaking the expenditure, since portable fences are very economical. While the distribution of adequate supplies is important, I believe that only such brooms and shovels should be distributed as will take care of the average force to be worked on each section. The placing of snow brooms and shovels at outlying switches is very helpful on important main lines.

The use of locomotives equipped with steam pipes for cleaning snow from switches and yard leads is more effective if applied to cleaning away the snow after the storm has ceased. When used during the progress of a blizzard, particularly if the temperature is low, the water from the melting snow forms ice very quickly; in most cases the switches are put out of service until the ice can be removed. Not infrequently,

this proves to be more serious than the handling of the drifting snow by other methods.

H. L. Stein (roadmaster, C. B. & Q.): There is one detail in connection with handling snow out on the line that should be given considerable emphasis. This is the importance of requiring the section foreman to make an early report of storms that may be in progress on his territory, as promptly as they would hard rain storms during the summer. Because of the time involved and the probable difficulty in getting over his section, the preliminary report can seldom be made in detail. He should, however, advise the superintendent of the character of the storm, whether the snow is drifting, the temperature then prevailing, whether the snow is dry or wet and the probable need for a snow plow. As soon as the storm abates, a report should be made of the depth, length and location of all snow drifts.

On many secondary lines about the only snow fighting machines that are available are wedge-type push plows, which leave only a narrow lane through the drifts, so that a later storm, which may otherwise be of small consequence, may easily blockade the line. In these circumstances, I have found the spreader-ditcher to be a valuable aid in widening out and even removing all of the snow from cuts, after the plow has been run. If the cuts are too narrow to permit the use of the spreader-ditcher, a self-propelled crane equipped with a clamshell can often be used to advantage for removing the accumulation of snow.

Another important thing about handling snow out on the line is the draining of drifts in cuts. During thawing weather, the snow may melt rapidly. If the ditches are full of ice, as often occurs, this ice will not melt as rapidly as the snow, so that the water from the melting snow tends to overflow the ditches and flood the roadbed. Where this happens, a sudden drop in temperature, or even the normal fall that comes at night, may create a bad condition or even a real hazard.

Still another matter which, because of its importance, should never be overlooked is that of keeping the flangeways in highway grade crossings clean. During the progress of a storm and immediately subsequent to it, the operation of highway snow plows should be watched carefully, since the operators often run them over grade crossings, but not stop to clean out the flangeways or remove the ridges of snow that are left on the tracks. Where the sections are long, a foreman may be unable to get to all of his troublesome crossings in time to care for them. Where this occurs, it is desirable to have arrangements with some reliable local man who will assume the responsibility for the crossings in his town.

J. J. Desmond (division engineer, I. C.): I agree fully with the committee that the most important step in handling of snow is that the preparation shall be made in sufficient time and that when one storm is over it is not too early to start preparing for the next one. On the Illinois Central we assign members of our engineering, signal and water service staff as foremen, to handle the gangs of extra men whom we are forced to employ. We have an aggravated condition with respect to safety, owing to the almost noiseless operation of our 500 scheduled electric suburban trains. By properly instructing the electric-train operators, however, and by requiring that they sound the bell and horn in all congested areas, interlocking plants, and at other points where men are likely to be working; and the further requirement that headlights must be lighted day and night during the progress of the storm, we have been very successful in avoiding injuries.

At Randolph street, and at the interlockings at Fifty-first and Sixty-seventh streets, we are using electric snow melters. They have been so satisfactory that we have recommended an extension of their use. At other points we have used with a high degree of success about 4,000 portable oil-burning snow-melting pots. I do not agree with the committee that the most successful operation of these pots is insured by placing them under the switches after the snow starts falling.

We are using crawler-mounted tractors equipped with bulldozers to keep driveways clear at team tracks and freight houses, as well as at the mail building at our terminal station. We have found an advantage in putting a snow lifting attachment onto the tractors for loading snow into trucks and coal cars.

J. B. Kelly (general roadmaster, M. St. P. & S. STE. M.): Plows in general use have a flanger between the trucks, which leaves the front truck exposed to uncleaned flangeways, often resulting in derailment that might have been eliminated at a small outlay for an air-operated flangeway and rail head ice cutter attached to the truck and placed just ahead of the front wheels. The type of track flangers ordinarily used are of little real effect after winter snows have accumulated, especially where it is difficult to keep the snow cuts widened out, as the flangers simply throw the snow against the snow side walls and it is returned to the track. In this situation, the elevator flanger is ideal. This device can be attached to the rear of the car in the form of a square-nosed plow with a V-mold board, extending about 10 ft. in height. The flanger section is raised and lowered by air, and when operated at a speed of 35 to 40 miles an hour will convey the snow from the track to a good clearance on top of snow cuts.

Where engines have been stalled for some time during severe weather, it is not uncommon to find the track badly iced after they are moved, even though it has been thoroughly cleared. This is because the heat from the fire box has heated the rails and ballast, so that for some time they will continue to reduce the drifting snow to water. For this reason, it is well to make sure that a dangerous condition has not been created.

In bad snow territory, the expense of handling such snow as may be accumulated by uncut weeds and brush in close proximity to the track and above the level of the rail, is often many times the cost of clearing the right of way in advance.

It is a decided economical advantage to have highway crossings equipped with self-cleaning flangeways, such as are provided by a light section of rail headed into the web of the running rail and held against rolling by a welded support to the head and base. Rigid type frogs are a decided relief in main lines, and through yards where ice and snow are usually heavy. Steam lines are a necessity in turntable pits. One and two-horse snow scrapers, of such a design that they are adapted for operating over track rails, switches and platforms, provide an excellent means for keeping leads and stations facilities cleared of snow.

E. E. Crowley (roadmaster, D. & H.): We have been using a snow fence of the picket type mentioned by the committee for the past three years and have found it to be very effective. We hang the picket fence onto the woven-wire fence, wiring it to the latter to hold it in place and keep it from sagging, which it will do otherwise, especially if any weight of snow is placed upon it. We also find it advisable to install additional fence posts, placing them about eight feet apart, to insure ample support under severe drifting.

Another inexpensive type of drainage not mentioned by the committee, which can be installed, consists of a steel drum with the bottom cut out, sunk to an elevation that will insure its being below the frost line. The top can be either perforated or cut out. If the latter, it should be covered with a steel grating; this being more desirable as it permits the cleaning of the drum without the necessity of digging it up. We have had some of these drums in service for as long as 10 years and they have been very effective.

I am pleased to note that the committee has stressed the importance of safety in distributing men; especially of placing experienced men with inexperienced men. This practice not only minimizes the danger of death or injury on the part of the inexperienced employee, but it is also a means of assuring that the new men are on the job and that the right amount of work is being obtained from the extra men who are called into service during severe snow storms.

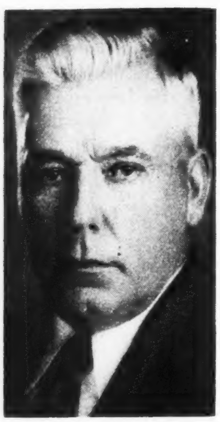
T. F. Donahoe (supervisor of track, B. & O.): In the vicinity of Pittsburgh, we seldom have heavy falls of snow. Our principal troubles have resulted from the drifting of snow into the switches of yards that are located along the rivers. When this occurs, we find that the best plan is to have one experienced man follow each yard crew and sweep the open points as they are used, and to provide brooms for all of the yard crews. The men who follow the crews can each have a broom, rattan preferred, with a chisel point at the end of the handle, and a two to three-gallon can of carbon oil, with a pump and burner, to use for melting any snow that clings so tightly to the switch or track rails or switch rods that the broom will not dislodge it. For clearing switches, engines can be equipped with air lines in place of steam pipes under the foot boards. While air is not quite as effective as steam, it does give excellent results. It has the advantage that no water is left from melting snow, and there is no cloud of condensing vapor to interfere with the crews of adjacent engines.

Locomotives that are equipped in this manner will take care of light snows, up to four or five inches, until a snow-fighting force can be assembled. A separate hose with a 3/8-in. valve and nozzle will be of great assistance in cleaning any snow that is not blown out by the perforated pipe.

By putting one to two inexperienced men with him they can keep a ladder open. In the territory where we have centralized traffic control, we keep brooms in all the telephone booths so that trainmen can make switches safe for operation. These switches are adjusted to fit up tight and will, therefore, fail easily.

Water Pockets—Their Cause and Cure

REPORT OF COMMITTEE



M. H. Murphy
Chairman

THAT the necessity for suitable and adequate roadbed drainage has been recognized from the time of the first railways is indicated by the fact that as early as 1828 definite instructions had been prepared directing the superintendent of construction of the Baltimore & Ohio how such drainage should be provided. It was also stipulated that "French drains shall be constructed of such size and form, and in all such places, as the superintendent shall require." Evidence that proper drainage was not always provided, however, is found in "American and European Railway Practice" by Alexander Holley, published in 1860, where it is stated that "observation and science alike show that in earthwork (including its drainage), more than in any other single detail of our construction, are American railways deficient. Subdrainage is doubtless both cheaper and more efficient than the system of open ditches." Indicating that this neglect to provide proper subsoil drainage was not confined solely to the early days of railroading, the Committee on Roadway of the American Railway Engineering Association made a report in 1903, in which it stated that "it is probably true today that drainage, especially under-drainage, is attended to far less perfectly than its importance demands."

The subgrade must support not only the dead load of the ballast and track, but the heavy loads of locomotives and cars which are transmitted to it with a certain amount of impact. Unless the material of which the roadbed is constructed is stable under these loads, the ability of the subgrade to sustain them is impaired and it is unable properly to perform its function. Good track, therefore, depends on the stability of the roadbed. It is the common experience, however, that stability of the roadbed depends in large measure on keeping it dry and that this can be done only by providing adequate drainage.

Water Pockets a Common Maintenance Problem

Water pockets, which constitute a common maintenance problem, have existed since the construction of the first railways. They may be the product of either natural or artificial conditions, yet they are able to persist only through failure to provide proper and adequate drainage. They are found in cuts and on embankments. Those which are the product of natural conditions result from water reaching and being held in the soil by capillary attraction. Those resulting from artificial conditions generally contain free water which is retained because of improper, or complete lack of, drainage.

Water pockets are formed in various ways. They may be due to the use of unstable material in embankments or to failure to remove such material from the subgrade in cuts; to the placing of frozen material in winter; and to an excess of timber from temporary construction trestles or filled trestles, which later decays and leaves cavities for the reception and retention of the water.

Too often the subgrade is not allowed to settle properly before it is used. The operation of trains over an unseasoned roadbed, without ballast of the proper quality or depth, tends to form depressions in the surface of the roadbed, which are quite certain later to develop into water pockets.

Water pockets are often formed in an old roadbed that has previously been free from this trouble, by constructing a new subgrade of impervious material and at a higher elevation alongside existing tracks. Similar re-

sults may be expected to follow the widening or raising of an old roadbed with impervious material, unless extreme care is exercised to insure that none of this material is placed above the bottom of the ballast.

Several years ago when locomotive axle loads were being increased rapidly, on many roads water pockets began to form at points where the roadbed had previously been stable. Investigation developed in many cases that the ballast, which had previously been of sufficient depth to support and distribute the wheel loads, was being pounded down into the roadbed to form basins for the reception and retention of water. Likewise water pockets are likely to occur at any point where an insufficient depth of ballast is being maintained or where other conditions permit the entrapment and retention of water in the roadbed.

Curing Water Pockets a Matter of Drainage

Curing water pockets is merely a matter of providing adequate drainage for the purpose of removing water from the roadbed. Neither the water absorbed through capillary attraction nor that entrapped in basins formed through the pounding down of the ballast ever dries

Water Pockets Often Extend to a Great Depth

out from under the track through natural means. For this reason, artificial drainage must be provided. This statement sounds simple, but the practical matter of providing proper and complete drainage is not always so simple.

In the first place, practically all of the soils which obtain their water through capillary attraction are reluctant to release it. About the only remedy in this case is to provide a system of drainage which will lower the ground water level sufficiently to decrease the amount of moisture susceptible of capture through capillary attraction.

In providing a system of drainage for water pockets, the first consideration is the removal of all of the free water, not only from the basin itself but also from the surrounding soil. To accomplish this, soundings should be taken to determine the depth of the water pockets, or of the source if the water is present from an independent or outside source. In cuts, a main drainage sewer of vitrified sewer pipe having open joints, or of perforated corrugated metal pipe, should then be laid at the proper depth below the surface ditch.

This depth is determined primarily by the depth of the water pockets, but should be well below possible frost action. It should also be of sufficient depth and have the proper gradient to insure quick drainage during and after storms or prolonged rainfall. In any event, the pipe should be laid below the zone where displacement in either line or grade might occur as a result of subsidence or distortion of the roadbed by traffic. The size of the pipe is also of importance. Eight inches should be the minimum diameter, and this should be increased as needed between the summit of the grade and the outlet so that there will be no question about the ability of the pipe to take the drainage from the laterals.

At the proper intervals, and this can be determined only after a thorough investigation of all of the conditions surrounding the particular project in hand, laterals should be extended under and across the track, the depth being such that they will drain the lowest points in the pockets. In any event, there should be a minimum of one lateral to a rail length. Where the conditions are particularly difficult, this should be increased to three or even four to a panel. Extreme care should be exercised, however, to avoid locating the lateral trenches under rail joints. Pipes for laterals should be not less than six inches in diameter.

Backfill with Permeable Material

Trenches for both the mains and the lateral pipes should be backfilled with permeable materials and a bed of similar material should be provided under the pipe. Many roads use locomotive cinders for backfilling. Others use crushed stone or slag, while still others prefer washed gravel. Where corrugated metal pipe is used, cinders are not suitable because of their corrosive action. If either the main or lateral is laid in a very muddy cut or one containing quicksand, it may be wise to support it on a timber foundation, consisting of a plank with a strip nailed to each side to hold the pipe in line. If quicksand is encountered, it may be desirable also to pack straw around the pipe before the trench is backfilled.

Two plans are commonly used in placing the main sewer and laterals. Some maintenance officers require mains to be laid on both sides of the track and connect the laterals alternately to them. Others install a main on one side only, leaving the other side of the track untiled, and connect all laterals to this main. While the committee believes that the first method is likely to give the best results, it is not prepared to make recommendations, since in many cases the single main seems to be satisfactory, in which event, the cost of the second main may not be justified. It does recommend, however, that every case be studied carefully with a view to determining definitely that the cost of the second main is not justified before the decision is reached to eliminate it from the plan.

Sometimes it may be practicable to construct lateral drains of the French type, thus avoiding the use of the pipe. This should be done with great caution, however, since quick and positive drainage is necessary to insure a permanent cure of the conditions created by water pockets. Where laterals of this type are desired, the trench should have a width of two to three feet and a depth that will reach from 12 to 18 in. below the bottom of the water pocket. It should be filled with coarse, hard, broken stone, preferably of ballast size, to the elevation of the subgrade, above which locomotive cinders, gravel or other fine permeable material should be spread to prevent dirt sifting through and blocking the drainage.

Conditions and methods of cure may be practically alike for both cuts and fills, except that in high fills the main sewer may not be needed, where proper outlets for the laterals, whether pipes or French drains, can be secured. In some cases on multiple tracks it is desirable to place the main sewer between tracks and carry it to convenient outlets at regular or irregular intervals. Where water pockets occur in low embankments, the main sewer can be laid in the natural ground alongside the track in the same way as in a cut.

We have a report that on one division of the Chicago, Burlington & Quincy troubles caused by water pockets in cuts were corrected by driving a row of bridge ties, as close together as the operation of the pile driver would

On Embankments the Main Sewer Can Be Laid Between Tracks

permit, parallel to the rail and along the ends of the track ties for the entire length of the water pocket.

The Chicago & North Western reports that its method for correcting water pocket troubles in a fill along the Missouri River bottom in northwestern Iowa, where the trouble had been long standing in a gumbo embankment, was as follows: The water pockets, which in many cases had grown to such an extent that they were forming continuous water troughs, were caused by the pounding down of the ballast into the gumbo embankment material directly under the track. The depressions thus formed were repeatedly filled with gravel until the ballast section under the track became V-shaped and several feet in depth. At the same time that the gumbo pounded down, it also crowded out on the sides, creating impervious troughs which filled with water, resulting in a track structure which could not be maintained in cross level, line or surface. The maintenance cost over these sections was very high and speed restrictions were necessary the year around, for the reason that it was impossible to hold the track to line or surface. It frequently became badly distorted within 24 hours after a complete reballast job was finished. All kinds of known water pocket drainage had been tried out extensively with only temporary relief in each case. French blind drains which were installed became disrupted and filled by the constant moving of the gumbo material. Perforated wooden boxes and perforated iron pipes, though laid on a good outward grade, were driven down to the extent that the inlets soon became lower than the outlets. Holes dug along the toe of the slope into the sandy alluvial soil below the gumbo resulted in quick drainage of the right of way, so it was decided to try holes in the center of the track just outside the rails. A series of these holes, made for test purposes and backfilled with rock, drained the track section so rapidly and completely that the practice of constructing rock-filled or cinder-filled vertical drains was continued with very satisfactory results.

At first, a rigid-auger machine boring a 10-in. hole in the center of the track was used but in view of the fact that the lowest point of the water pocket or trough was not always immediately under the center of the track, a turn-table rig was constructed to put down the holes either in the center of the track or alongside. The vertical drains so constructed have been giving very satisfactory results for the past two or three years. The drains were constructed under contract to a depth of 20 to 30 ft. When spaced about 14 to 17 ft. apart or about opposite every rail joint and filled with screened ballast from alongside the track, they cost an average of $0.39 a lineal foot of the track.

Prevention Better Than Cure

Important as it is to drain water pockets once they have formed, or while they are in process of formation, prevention is of far greater value. In many cases, the cost of prevention is less than that of cure. In fact, it may sometimes be very small. With the exception of drainage, probably the most important factors in the prevention of water pockets are the proper design and construction of the roadbed and the application of a satisfactory depth and kind of ballast.

Since precautions leading to prevention should begin during the construction period, the subgrade should be crowned uniformly and given a sufficient lateral slope to insure surface drainage. Obviously, construction tracks will be required, but they should be removed and the roadbed smoothed up and rolled with a 10-ton road roller before tracklaying is permitted. At this time and during the period of grading, if any backfilling is required, the backfilling material should be the same as that used in the roadbed.

Permanent tracks should never be laid on an unconsolidated fill. Where tracks must be laid before natural consolidation through settlement can take place, the fill should be built up in light horizontal layers, each of which is consolidated as it is placed by means of a 10-ton roller or its equivalent. After the tracks are laid, the operation of trains over them should be forbidden until they are properly ballasted. Stone, slag, chatts or coarse washed-gravel ballast should never be applied directly to a green roadbed, particularly if constructed of clay or loam, even though it may have been properly consolidated. Where any of these materials is to be used for ballast, a sub-ballast, consisting of a layer of finer material which will not settle readily into the subgrade or permit the roadbed material to work up into it, such as locomotive cinders, clean bank-run gravel or other suitable material, should first be applied to the roadbed to a minimum depth of eight inches but preferably to a depth of one foot or more. Above this, the normal ballast should have a depth sufficient to insure an even distribution of the traffic loads to the roadbed.

Conclusions

1. Water pockets are a product of unstable soil conditions which result from an excess of moisture. This excess moisture reduces the bearing power of the soil, increases its plasticity and tendency to flow.

2. Water pockets are created directly by loading the soil beyond its bearing ability, thus pressing the ballast into the plastic material to form a depression into which water collects and aggravates the condition.

3. They may be created indirectly by errors of construction, such as failure to provide a smooth, properly crowned roadbed; by permitting trains to operate over new tracks before they have been properly ballasted; by operating trains over ballasted tracks before the roadbed has been properly consolidated; by boxing in the ballast when widening the roadbed or raising the subgrade of an operated track; and by constructing an embankment adjacent to an existing fill but at a higher elevation.

Permanent Cure Demands Effectual Drainage

4. Water pockets can be cured only by providing adequate drainage. The method of providing this drainage must be determined by the conditions surrounding each particular project.

5. Prevention is more satisfactory and usually cheaper than cure. Prevention can generally be accomplished by correcting the errors of construction, providing a proper depth of suitable ballast and installing such drainage as may be necessary to drain the soil or cut off the source from which the water reaches the roadbed.

Committee: M. H. Murphy (chairman), supervisor, Chicago & Alton, Slater, Mo.; W. M. Anderson, roadmaster, Seaboard Air Line, Birmingham, Ala.; L. F. Brean, assistant roadmaster, Maine Central, Bartlett, N. H.; Curtis E. Brown, roadmaster, Panhandle & Santa Fe, Slaton, Texas; E. T. Dearth, roadmaster, Missouri Pacific, Coffeyville, Kan.; F. H. Depew, roadmaster, Southern Pacific, Watsonville Jct., Cal.; A. L. Kleine, roadmaster, Atchison, Topeka & Santa Fe, Marcelline, Mo.; R. E. Meyer, roadmaster, Chicago & North Western, Wall Lake, Iowa; R. W. Putnam, roadmaster, Southern Pacific, Oakridge, Ore.; Wm. L. Spyres, roadmaster, Kansas City Southern, De Quincy, La.

Discussion

E. C. Buhrer (supervisor of track, N. Y. C.): This committee has covered its subject in a very commendable way and deserves much credit for its effort. Maintenance officers, who have had water pockets develop under their tracks, are well aware of the hazard and expense they create. A water pocket is originally an invisible defect, which grows rapidly to large proportions unless it is taken care of at the first visible indication of its development. The development of a water pocket can first be detected when it causes the subgrade to raise at the end of the ties or causes the fill to bulge. If it is given attention as soon as this condition is observed, it can be cured with little effort and only a minor expense, since at this time it is not deep and can be drained with very shallow drains. If not given attention at once, however, it will gradually deepen. Water pockets are generally deepest under the rail. I have seen cases where water pockets on fills had continued to develop until they were as much as 10 ft. deep under the rails. A pocket of this depth creates a real hazard and is expensive to cure.

I have had very satisfactory results in curing water pockets of this depth on fills by driving a row of piling about one foot outside of the ends of the ties, putting the piling four feet apart. The cheaper grades of piling can be used for this purpose. Such pockets can also be cured by trenching the shoulder of the fill with a clam shell and backfilling the trench with porous material, leaving outlets at different points so the water can get out of the fill.

Money Not Always Available

Maurice Donahoe (division engineer, Alton): This report is thorough and contains excellent information both as to the causes of water pockets, their cure and prevention. Water pockets comprise a treacherous form of defect in the roadbed, with which section foremen and maintenance officers are often at their wits end to cope. Oddly, it seems difficult to obtain the appropriations necessary to eliminate the condition by means of subsoil drainage or other methods mentioned in the report. This has been particularly true during the past four years when expenditures for roadway maintenance have, of necessity, been limited drastically.

As a result of failure to obtain authority for doing the work in accordance with accepted practice, maintenance men have been compelled to devise inexpensive remedies, bearing the expense out of their allotments for track maintenance. These expedients include French drains, the deepening of surface ditches enough to drain or partly drain the pockets and numerous other expedients. The latter method must be applied during the early stage of the development of the water pocket, however, before it has become too deep to remedy by means of surface drainage. The time and labor required to keep the track at these places in line and surface can also be reduced some by spacing the ties over the area affected as close together as the necessity for tamping will permit, and by using soft ballast that lends itself readily to shovel tamping.

A track foreman who has several water pockets in his track, which require tamping and lining one or more times in a week, has a real responsibility, but one which is shared equally by the division maintenance officers who, too, have been constantly on the alert to insure that these places are given attention before they cause a derailment. Settlement at water pockets is invariably to one side or the other of the track, but frequently this settlement changes from side to side with almost consecutive regularity, making a most difficult combination of irregular cross level and defective line.

Tracks laid on subgrades that are constructed of material that permits the easy development of water pockets and soft places in the roadbed, particularly if they carry a heavy traffic, should be given preference in any program looking to a cure. Every case of soft roadbed and water pockets should, however, receive the thoughtful consideration of the management with the idea of providing appropriations to cover the subdrainage necessary to eliminate them.

O. Suprenant (roadmaster, D. & H.): This report is a very practical one, both as it refers to the actual

conditions that are found and the cure of the trouble. In the past, most railway construction has been carried out in a hurry, by either a contractor or the railway itself, and little consideration has been given to drainage. For this reason, our tracks are full of water pockets. Surface drainage has been maintained by all roads, but a surprisingly small amount of work has been done toward eliminating water pockets. To drain the track successfully, this work must be programmed yearly on every section, giving consideration to the worst spots first.

When we come to cuts, I am very much in favor of running a parallel main sewer on one side with lateral drains connecting to it from the other side. The main drain should be built with vitrified sewer pipe having a minimum diameter of 8 in It should be below the frost line and the trench should be back-filled with ballast-size crushed stone. The lateral drains should be of the French type.

Where water pockets occur on embankments, I prefer French drains with large stones at the bottom which should be overlaid with ballast-size stone to the top. The bottom of the drain should always be well below the bottom of the water pocket and the outlet should be so protected as not to endanger the embankment from washouts.

Settlement in the track indicates clearly and quickly where this kind of work is needed, so that effort should be applied to such places only. It is my belief that a yearly program of drainage on every section where it is required, followed up closely, will be more economical than a more extensive program that provides for starting at one end of a road and continuing until the other end is reached. In most cases, our regular section forces can afford to do this work during the winter when it can be done at substantially no extra cost.

W. H. Sparks (general inspector of track, C. & O.): While I would not detract in any way from the work of other committees, I am convinced that this committee has been studying one of the most important subjects with which maintenance officers have to deal today. Oddly enough, despite their importance from the standpoints of track maintenance and train operation, it appears that water pockets are often viewed with a certain amount of indifference, and there can be no doubt that maintenance officers, either through ignorance of the causes or of the remedy, often woefully neglect to make the effort required to effect a cure.

I hold that what the committee has said with respect to the causes of water pockets is true. If I were to make any criticism of this part of the report, I would base it on the fact that, to my mind, not enough emphasis was placed on the errors which construction engineers are so frequently led to commit by the pressure that is nearly always applied to force new lines or other facilities into service before the job can be finished in a workmanlike manner. We are prone to blame the engineers for our later maintenance troubles, and perhaps they are to blame in part, but in large part these troubles are the responsibility of management.

There may be economic and operating advantages in starting to use a new facility at the earliest possible moment. A little investigation should convince any intelligent operating officer that the earliest possible date is not always the earliest practical date. In other words, the economic advantages of early use may be more than offset by the difficulties and expense of later maintenance as they have been so clearly set out by the committee.

I am also in accord with the methods of cure which the committee has outlined. A word of caution is not out of place here, however. Many times an energetic effort has been made to effect a cure where water pockets have formed, but this effort has been completely nullified by failure to lay the drainage pipe, both mains and laterals, deep enough to dispose of all of the water. No permanent improvement can be expected without complete drainage of the water already in the pocket, in addition to cutting off the source of supply. For these reasons, money is well spent in making a complete exploration of the conditions before plans for the drainage system are started.

Another word of caution concerns the size of drains. There is always a tendency to keep the size of drains down, with the result that many of them are too small. While they should be selected with judgment, this is one place where there is a distinct advantage in being liberal. I am fully in accord with the committee that the minimum diameter for laterals should be 6 in. and for mains, 8 in., with liberal increases as the outlet is approached.

This is a case where an ounce of prevention is often worth many pounds of cure. The relatively simple means whereby the errors of construction can be avoided have been discussed quite fully by the committee, and I have no suggestions in this connection. I would like to stress more fully, however, the desirability of installing suitable and adequate drainage, which will insure that the roadbed will remain dry, during the construction period. Too frequently, the construction department takes the position that the maintenance forces are better qualified and equipped to provide this drainage at lower cost after the line is in operation. Where this is done, the cost of the drainage system itself is increased, while other evils follow, which might have been avoided if a different attitude had been taken.

The Track Supply Association

SOME effort has been made to display track materials, tools and equipment at every convention of the Roadmasters Association since the first meeting in 1883, but it was not until 1910 that properly conceived exhibitions were put on a sound basis by the formation of the Track Supply Association. That the founders of this organization of supply manufacturers were motivated by sound business principles and high ideals in their relations as vendor to their prospective buyers is attested by the marked improvement that occurred at once in the character of the exhibits shown. It is evidenced also in the growth of the Track Supply Association, not only in the number of firms participating but also in the diversity of the exhibits and the increase in the floor space occupied.

Thus, the maintenance of way officers who have attended the conventions of the Roadmasters Association have not only been afforded an opportunity to discuss problems of mutual interest but have also been given an opportunity to study and examine full-size examples of practically all of the tools, equipment and appliances available for use or application in their work. No better measure of the appreciation manifested by the roadmasters of the value of the exhibit can be offered than the fact that the decision as to the place of meeting is always

predicated on the requirement that adequate accommodations must be available for the supply show.

But it is not only in providing an exhibit, that the Track Supply Association has been an asset to the Roadmasters. Close co-operation between the officers of the two organizations, fostered through years of intimate relations, has built up a spirit of mutual helpfulness that has been of untold benefit to both organizations. The Track Supply Association is proud of its good name and its officers have been constantly alert to guard against objectionable practices on the part of overzealous or undisciplined representatives of its members. Its officers have also exercised discrimination in the recruiting of memberships to insure that its exhibits shall be truly representative of the high calibre of the railway supply industry.

The officers and directors of the Track Supply Association who have carried on its activ'ties since the last convention of the Roadmasters in 1930 are as follows: President, Dan. L. Higgins, The American Valve & Meter Co., Chicago; vice-president, G. T. Willard, International Railweld Corp., Chicago; secretary-treasurer, L. C. Ryan, Oxweld Railroad Service Co., Chicago; Directors, L. S. Walker, P. & M. Co., New York; George M. Hogan, Sellers Mfg. Co., Chicago; Ward B. Maurer, American Hoist & Derrick Co., Chicago; F. J. Reagan, The American Fork & Hoe Co., Chicago (elected to fill the vacancy resulting from the death of Emmett Keough); ex-officio, L. P. Shanahan, American Steel & Wire Co., Chicago; honorary director, Elmer T. Howson, President Roadmasters & Maintenance of Way Association. A message to the Roadmasters Association on behalf of the Track Supply Association follows.

A Message from President Higgins and Secretary Ryan

SINCE 1910 it has been the privilege of the Track Supply Association to participate in the annual conventions of the Roadmasters and Maintenance of Way Association of America, with opportunities to renew old acquaintanceships among the roadmasters, and with facilities to introduce and display the products of the various member companies. The individual members of the Track Supply Association have always looked forward with pleasure to these conventions and keenly regret that conditions necessitated the abandonment of the conventions in 1931 and 1932. For this reason they greatly appreciate the opportunity now afforded them, through the courtesy of *Railway Engineering and Maintenance*, to participate in a "Convention in Print."

The Track Supply Association was formed in 1910 with the object of providing the organization and facilities for the conduct of well-ordered exhibits at the annual conventions of the Roadmasters Association, so that the various manufacturers might display the supplies, tools and devices which they offered for sale. Previous to that time, efforts of the supply men to the same end had met with rather indifferent success, but following the creation of the Track Supply Association, the activities of the two organizations have gone hand in hand with no interruption until the abandonment of the convention in 1931. However, in spite of the depression the Track Supply Association has kept its membership intact.

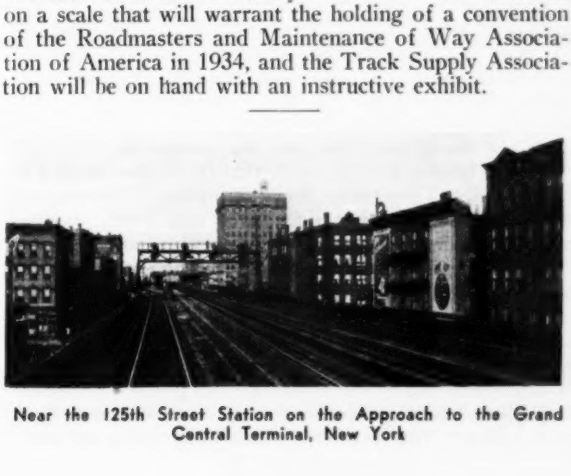
This association has enjoyed a steady healthy growth from the beginning, starting with 20 members in 1910, and having a membership roll of 79 in 1930. Its exhibitions have also expanded from year to year with respect to the number and variety of the products shown, and the amount of space occupied for display purposes. Furthermore, its relationship with the Roadmasters and Maintenance of Way Association has become more intimate from year to year until now the Track Supply Association has come to be considered almost an integral part of the roadmasters' organization.

Although general business conditions prompted the decision of the Roadmasters Association to abandon its annual conventions in 1931 and 1932, the Track Supply Association has held its organization and membership together and conserved its financial resources so that it is in a strong and healthy condition today, ready and eager to present an unusually attractive exhibit in connection with the Roadmasters annual convention of 1934, which we feel confident will be the greatest convention in the history of the association.

During 1931 and 1932, when the Track Supply Association would otherwise have been inactive, its directorate, anxious to do something constructive in the interest of the railroads and their employees, as well as for the business of its own membership, fostered the "Ship by Rail" movement. These activities were directed by a committee consisting of George M. Hogan (chairman), Frank J. Reagan, I. B. Tanner, W. H. Lawrence, George E. Johnson, George T. Willard, L. C. Ryan (secretary) and Dan J. Higgins (vice chairman).

This "Ship by Rail" movement received the hearty support of the Track Supply Association and also enlisted the help of numerous other companies interested in railway materials. All those who had a part in this movement, fostered by the Track Supply Association, agreed to confine their freight and passenger business to the railroads, to the exclusion of subsidized competing transportation agencies. While those who participated may not point to any definite and final accomplishment beyond their own consistent support of the railroads from whom they derive a substantial portion of their business, they still feel that their early efforts in the movement did much to swell the tide of public opinion toward the abolition of state and federal subsidies for transportation agencies that compete with the railroads. In this effort to enlist the entire railroad supply industry in behalf of the movement, the "Ship by Rail" committee contacted hundreds of industrial companies and actively engaged in propaganda for the cause.

We believe that harbingers of better times are abroad, and that the program of the national administration through the well-directed efforts of the N.R.A. will soon restore business to normal conditions. All this, of course, means the return of profitable business to the railroads and the spending of large sums for deferred maintenance. We look forward confidently to the revival of business on a scale that will warrant the holding of a convention of the Roadmasters and Maintenance of Way Association of America in 1934, and the Track Supply Association will be on hand with an instructive exhibit.



Near the 125th Street Station on the Approach to the Grand Central Terminal, New York

What's the Answer?

Have you a question you would like to have someone answer?

Can you answer any of the questions listed in the box?

To Be Answered in December

1. What methods should be followed in keeping a line open during moderate snow storms? How do these methods differ as the snowfall becomes heavier but does not drift? When it is relatively light but drifts? When a heavy fall of snow is combined with severe drifting?

2. Does turpentine add to the tenacity of red lead when applied to steel surfaces as a priming coat? In what way? How much turpentine should be used?

3. Where additional anti-creepers are needed, should they be applied in connection with tie renewals, surfacing, etc., or should their application be deferred until winter? Why?

4. To what extent can building details be standardized?

5. On curves, should the high or the low rail be selected as the line rail? Why?

6. What instructions should govern the cleaning of roadside water tanks where an untreated muddy water is used? Where the water is filtered, is clear well water or is obtained from a reservoir? Where it is pumped unfiltered from a lime-soda ash softening plant? Where it is treated with compounds in the roadside tank?

7. Should track be surfaced in the early winter after frost has penetrated to a depth of two or three inches? If not, how can rough track be corrected? Can track be lined at this time?

8. How should one go about replacing a stringer in a creosoted ballast-deck trestle? The placing of one or more additional stringers to reinforce the deck?

Dressing Track

Should a section gang that is doing routine surfacing or making a light renewal of ties be required to fill in and dress the track at the close of each day's work? Why **?**

Track Should Always Be Filled

By GEO. M. O'ROURKE
District Engineer, Illinois Central, Chicago

A section gang doing routine surfacing or making a light renewal of ties should always be required to fill in and dress the track at the close of the day's work, for if the ballast section is not restored and it rains during the night, drainage may be obstructed. Also during hot weather, open track is much more likely to buckle than track that is properly filled. Anti-creepers are afforded less resistance where the track is not filled, thus aggravating any tendency of the rail to creep. Unfinished work of this character is a reflection on the supervision that is being provided. To allow it is poor training for foreman and supervisor alike.

Desirable for Several Reasons

By I. H. SCHRAM
Engineer Maintenance of Way, Erie, Jersey City, N. J.

It is axiomatic that all track work should be done in a workmanlike manner, including the dressing of the ballast which is needed to complete it. If this part of the work is allowed to lag, other work which is essential for either safety or good riding is also generally neglected. For instance, it has been found that where foremen have not finished the dressing of the track after tie renewals, the spiking also was not completed.

In soft ballast, it is desirable that the ballast section be maintained to keep water from getting under the ties and churning. When this action starts on newly tamped track, it becomes very difficult to prevent damage to the track structure without replacing the ballast at this particular location. It is desirable, therefore, and economical as well, to get the track filled at once.

Open track that is not protected by proper notice or slow orders, such as are issued in connection with reballasting, even where the extent of the project is limited, is likely to cause personal injuries to trainmen or others in the dark. This is an additional reason why the track should be kept filled currently. It is also quite possible that track thus neglected may be left open for several days, since some emergency, such as a derailment or sudden storm, often keeps a section gang away from its routine work for several days.

Filling Track Is Safest Practice

By W. H. SPARKS
General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

When doing routine surfacing, there is no reason, so far as I have observed, why a foreman should not be required to keep his track filled and dressed currently. When renewing ties, whether the renewal is light or heavy, the track should be filled in and the ballast smoothed, but I question the need for dressing it every day. It has been my experience that such track needs

to be gone over a second time, since weak places always develop no matter how carefully or well the work is done. In view of this, I believe that the time spent in dressing the track at the end of each day's work is wasted.

It was my custom as track foreman and later as supervisor to assign the first four days of the week to tie renewals. Then I went back and picked up all of the weak places that were discernible in both surface and line, following which I dressed the track.

Never Sure of Next Day's Tasks

By ROBERT WHITE

Section Foreman, Grand Trunk Western, Drayton Plains, Mich.

A section gang that is doing routine surfacing or making a light renewal of ties should be required to fill in and dress the track at the end of every day's work. A section gang is never sure of what it is going to do tomorrow. A derailment may occupy its time for several days. It may be required to assist another section, or be taken miles from its headquarters in an emergency. It may be called on to help load, unload or lay rail and be away from home for several days. Should a heavy rain fall during the night, there is chance of a washout where the track has been left open. All old spikes should be picked up to avoid the possibility that they will be laid on the rails. All old ties should be piled ready for burning. If for any reason this cannot be done, they should be pulled far enough away to eliminate the danger of trainmen falling over them.

Track Stays in Better Line and Surface

By W. E. TILLETT

Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

By filling in each day's work, the track stays in better line and surface; there is less danger of the ties shifting and less tendency on the part of the rail to creep; and there is no hangover of uncompleted work to interfere with the next or some later day's tasks. When we are spot surfacing, every man in the gang keeps his shovel with him and as soon as he completes tamping a group of ties, he refills the cribs and dresses the ballast shoulder. Where the surfacing is more extensive or ties are being renewed, all of the gang engages in this principal job until it is completed for the day, when one man goes back to dress the track while the remainder smooth the line or surface as may be needed.

Should Complete Every Day's Work

By RINALDO ROSSI

R. Rossi & Son, Industrial Track Construction Company, Chicago

Any kind of track work done by a section gang in maintenance should be completed, so far as it has progressed, every day. In other words, no gang should be allowed to leave uncompleted work behind it. In the first place, open track is always a menace to trainmen or other employees whose duties may require them to pass over it on foot. This danger is generally greater around yards or through station grounds because of the larger number of persons involved.

In the second place, open track spoils the appearance of a section, results in poor track and invites a lower grade of work in other items of maintenance. No section gang ever knows that it will return tomorrow to continue the work it is doing today. Its absence may be only for a day, but it may be for a week or more. If the latter, the rail may creep, the ties shift and the line and surface deteriorate noticeably. If the open track is allowed to continue indefinitely, as it often does where requirements are lax, the final condition of the track may be worse than at first, while the foreman will have so much accumulated work behind him that he will never get it finished, and both his track and his record will be bad. Good housekeeping pays equally at home and on the section.

It Is Never Safe to Leave Track Open

By L. M. RODREK

Section Foreman, Minneapolis, St. Paul & Sault Ste. Marie, Medina Junction, Wis.

I am very much opposed to leaving track open longer than is necessary to complete the work for which it was opened. It is my experience that a section gang makes a serious mistake when it fails to fill in and dress its track after every day's work of routine surfacing or of tie renewal. If this is not done, a heavy rain may cause a washout, while in the ordinary course of events, the passage of cars and locomotives causes the track to get rough. Again, in hot weather, particularly if the rail is tight, failure to keep the track filled in sets the stage for sun kinks.

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Replacing Piles in Trestles

What methods are necessary and what sequence should be followed in replacing or driving additional piles in bents of ballast-deck timber trestles? Are these different for high and low bents? Why ?

Methods Differ for High and Low Bents

By H. AUSTILL

Bridge Engineer, Mobile & Ohio, St. Louis, Mo.

Where it becomes necessary to drive additional piles in the bents of a trestle of moderate height, and the purpose cannot be accomplished by driving better piles and springing them under the ends of the caps, I know of no way to drive them in an existing bent without removing the cap. Obviously, this is quite an expensive operation.

If the trestle is 25 ft. or more high, it is sometimes practicable to remove the bracing from the bent and drive the piles with the points set in line with the bent, and then spring the head of the pile under the cap and re-apply the braces so as to get a fairly good job.

We have replaced quite a number of individual defective piles by excavating several feet below the surface of the ground around the defective pile to reach sound timber. We then cut the old pile off and cut a new pile to exact length. After removing the bracing on one side of the bent, the posts thus formed can be stood on the old pile stump and sprung into place under the old cap to get a snug fit. The foot of the new timber is then fastened to the old stump by boring diagonal holes and driving drift pins in them. When the bracing is re-applied properly, this makes a very good bent, provided there are not too many such posts in it. Recently, we put 11 such posts 45 ft. long in one trestle with a labor cost of only $128.21.

I believe that rather than drive additional piles in a trestle of moderate height, if water underneath does not prevent, it is less expensive and entirely satisfactory to put posts on a spread footing between the piles in the bent, provided there are still a sufficient number of good piles remaining to provide the necessary lateral stiffness.

Should Select Slender Piles

By District Engineer

First of all, for trestles of all heights, it will be necessary to remove such of the deck planking as interferes with the pile-driving operation. It may also be necessary to shift one or more of the stringers to allow the pile to be driven in the desired position. If additional piles are necessary and these can be driven as batter piles to support the ends of the caps, the work can often be completed without disturbing the trestle. In other cases, a longer cap may be necessary to provide the proper bearing on the additional piles.

If the bents are 10 ft. or more in height, it will generally be practicable to drive the piles alongside the cap and pull them under after they have been cut off. Where this can be done, it avoids the necessity for removing and replacing the cap. If the bents are less than 10 ft. high, I know of no way to get the piles in proper position without removing the cap.

By selecting the more slender piles from his stock, a foreman can often reduce the amount of work involved in replacing piles in the bents of ballast-deck trestles. He will also reduce the probability of delaying traffic, since considerably less time is likely to be involved in pulling and holding the pile in place until it is finally secured.

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Clearing the Right of Way

Where the section forces are limited, how much time should be devoted to burning and otherwise clearing the right of way in preparation for winter? Should this be done as a special job or in connection with other work? Why

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Should Be Burned Thoroughly Every Year

By C. S. KIRKPATRICK

Chief Engineer, Gulf Coast Lines, Houston, Tex.

Because of the long growing season, our section of the country presents a very difficult problem with respect to keeping down weeds and grass on the roadbed proper, and brush on the right of way. We utilize mowing machines for mowing the shoulder, burners for burning it and discing machines for the purpose of cutting grass roots out of the ballast and keeping it porous so that it will drain. We find that this procedure keeps down the pumping of the ties and produces great economies in the way of ballast and labor that might otherwise be required. We work on the roadbed proper from toe line to toe line of the ballast and on the shoulders of the roadbed, commencing about May 1 and ending about November 1.

Under present maintenance conditions, when small forces are all that we can afford or expect, we cannot give the attention to the cutting of the right of way that we formerly did. In other words, it has been our custom to start about August 1 and cut all of our right of way during that month, in some cases using special gangs for the purpose. We still follow the policy, however, of clearing our right of way annually for in this section of the country, if this is not done, the vegetation soon becomes so large that it interferes with the telegraph and telephone lines.

At present, we are starting about July 1 and, as the section forces can be spared from track work, we proceed to clean the right of way, usually completing it by December 1. We do not attempt to cut the grass and weeds but we do cut all of the brush and bushes, and then pick appropriate times, when burning will do the most good, to burn the right of way. By this method, most of the weeds are burned and the right of way is left clean to the extent that there is nothing to interfere with the operation of the telegraph and telephone lines.

In all of our cleaning work, it is our policy to keep the weeds and grass down to such an extent as will enable our section forces to work the track at any point without their efficiency being interfered with by the necessity of having to stop and clean a lot of weeds and grass away before they can start actual track work. The same idea applies to the cleaning of the right of way. We do not expect to present a fine appearance, but strive only to keep the right of way in such condition from year to year as will make it possible to do any work economically that may have to be done along with it.

I believe strongly that the right of way should be cleaned off annually in the manner I have indicated. To let it go for two or three years will, in this section, greatly increase the expense of maintenance as well as hamper the efficiency of our labor.

Should Be Done as a Special Job

By J. E. BEATTY

Engineer Maintenance of Way, Eastern Lines, Canadian Pacific, Montreal, Que.

The proper time for clearing the right of way depends on the nature of the growth. In general, brush should be cut during the hot weather while growth is still under way, usually late in July. Grasses and weeds should be cut before seeds have a chance to mature. Where the section forces are limited, it is difficult to get this work done at the right time, but the growth of noxious weeds can be retarded materially in the ensuing year by a judicious burning of the right of way during the winter or early spring.

Mowing should always be done as a special job, so that scythes, snaths, grindstones, etc., will not have to be carried continuously on hand or motor cars, and also to insure that this work will be done before the growth seeds itself. In many cases, section laborers, when mowing, wear different boots and clothing than they do normally and for this reason also it is desirable to make mowing and brush cutting a special job.

Augmented Section Forces Recommended

By L. M. RODREK

Section Foreman, Minneapolis, St. Paul & Sault Ste. Marie, Medina Junction, Wis.

When the number of men in section gangs is as limited as at present, these gangs have about all they can do to keep the track in satisfactory riding condition. At this season, too, they have the added burden, particularly in the colder sections of the country, of being required to make special preparations for winter. No section foreman likes to admit that he is unable to do all of the work that arises on his section, and there are few of them that do not loyally try to do so. On most sections, however, the cutting of weeds and other work of clearing to right of way consumes a large amount of time.

With the limited forces which present conditions make necessary, this time is badly out of proportion to the total time of the gang. For this reason, if the section forces are compelled to cut the right of way and clear it of brush and other obstructions, and then burn it, the track will be neglected for an unreasonable time and there is a question whether many sections will be able to catch up

and keep abreast of their track work as they should, especially as the working season is rapidly drawing to a close.

I am strongly of the opinion that the right of way should be cleared and burned substantially as has been the practice in the past. Although heretofore this work has generally been done by the section forces, it has always been considered a special job which could not be done in connection with other work, since it requires special tools, special organization and special methods. In view of these facts, while I would not relieve the section forces from the responsibility for clearing the right of way, and while fully recognizing the conditions which have required the present drastic reduction in the number of section laborers, I am convinced that in the interest of better track conditions and proper preparation for the winter, extra help should be allowed temporarily for the purpose of clearing and burning the right of way and that this work should be done independently of any other work.

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Lining Track

How far from the lining gang should a foreman stand when lining long swings on tangents? How close for finished lining? Why? Where should he stand when lining curves **?**

Should Be as Far as He Can See Distinctly

By T. F. DONAHOE

Supervisor of Road, Baltimore & Ohio, Pittsburgh, Pa.

Long swings on tangents can best be lined by using a transit, but this method is not always practicable. Where the transit is not available two methods are open to a foreman. One is to use pieces of half-inch pipe about five feet long, painted white. One of the pipes should be set up at each end of the swing and the others at intermediate points. As the rail is thrown over and the pipes brought into line they provide fairly accurate centers to line by, and will give a far better line than can be obtained by the ordinary method of sighting along the rail.

Another method is to use a long light cord, say, 200 ft. long, using nails to hold the line. In application, the line is obtained by lapping each 100 ft. and extending the cord 150 ft. at a time, beginning back on the tangent and sighting toward the line at the farther end of the swing. It may require three or four trials before a satisfactory line is secured. The nails should be driven at least every 50 ft., and the amount of throw at each point is obtained by measuring from the rail to the nail.

So much for the methods of obtaining the correct line. When ready to throw the track, the foreman should stand at least 300 ft. away to pull the track roughly to the line that has been established. On the second trip, to correct the larger irregularities, he should be about 150 ft. from the lining gang. When putting on the finishing touches he should draw in to about 75 ft.

In lining curves that have only a few irregularities, the degree of curvature will govern the distance he should stand from the lining gang. On light curves, say up to three degrees, he should stand about 200 ft. away; from three to six degrees, the distance should be about 150 ft. On sharper curves it will be necessary to stand closer and use the low rail as the line rail.

If the curve has not been lined with a transit or by the string-lining method for some time, the foreman should go over it with a string to smooth out the irregularities which are never corrected by ordinary visual lining. In this way he will be able to approximate the original alinement, while by eye alone he is likely to make long swings out of short ones instead of obtaining a true line and a smooth riding curve.

Finally, when lining track an experienced foreman always stands back as far as he can see distinctly, whether lining tangents or curves.

Practices Vary Widely

By W. H. SPARKS

General Inspector of Track, Chesapeake & Ohio, Russell, Ky.

This is a question that cannot be answered categorically, since nearly every foreman has his own method of lining. As with practically every other item in maintenance, however, certain fundamental and well-defined principles underly the operation, and the variations in practice have been built upon these, so that the differences are superficial rather than basic.

From the form of the question, I assume that the lining is to be done without the aid of stakes. On this basis, when lining a long swing out of a tangent, I stand far enough from the lining gang to see the full length of the swing, transmitting my instructions by means of signals. I go over the track several times, the number depending on the magnitude of the total throw required, making relatively light throws each trip over, thus permitting a quick runoff in the line if a train approaches. As soon as the track is substantially to line, I reduce the number of men in the lining gang and start the finished lining. During this stage of the work, it is generally practicable to stand close enough so that instructions can be transmitted verbally.

Two things must be attended to if a good job of lining is expected. First all spikes must be driven down to a full bearing on the base of the rail and, second, the track must be put to correct gage. If these items are properly cared for, the track will throw easier, and will stay in line much longer.

When lining curves without the aid of stakes, the amount of throw at every point should first be determined by string lining. In general, it is advantageous to stand on the outer ends of the ties, since this gives the best view of the rail which should be obtained approximately along a line tangent to the curve at the point where the lining gang is working. The distance from the lining gang depends on the radius of the curve; in other words, the lighter the curve the farther away the foreman can stand and, vice versa, the sharper the curve the closer he must stand to be able to detect irregularities in the line.

No Fixed Rule Can Be Applied

By P. W. STARK

Roadmaster, Louisville & Nashville, Evansville, Ind.

There are so many varied conditions that must be considered and such a wide diversity in practices with respect to lining track that it is impracticable to apply a fixed rule to the position that should be assumed by the foreman when lining either tangents or curves. In other words, the distance that a foreman should stand from the lining gang is governed entirely by the range of his vision. In all cases he should be back as far as he can see distinctly, but in no case less than 15 rail lengths, or, say, 500 ft.

A foreman who is preparing to take out a long swing on a tangent should first make a careful study of the track to be lined. He should view it from both direc-

tions, carefully estimating the maximum throw as well as locating the point at which it will occur. With these data well-fixed in mind, he may start work at either end of the swing, increasing the throw from nothing at the start to the maximum, then decreasing it until the extreme end of the swing is reached.

This first part of the process—the rough part of the lining—may be done more readily by measurement. In either event, if the throw has been estimated or measured correctly, the finished lining can then be started. At this time, if the shifts that are to be made are less than a rail length, the foreman should stand from 6 to 10 rail lengths away from the lining gang. If the kinks exceed a rail length, however, he should be a minimum of 10 rail lengths away, to avoid the possibility of putting short reverse swings into his line. Where only short kinks remain to be taken out in the finished lining, the foreman can work to advantage from two to five rail lengths back of the liners. Where swings are located through vertical curves, it is good practice to estimate the maximum throw, and line from that point in both directions to the ends of the swings.

Since curves are no longer lined by eye, curve chords being used instead, only finished lining need be considered. When doing this work, foremen should stand about three rail lengths from the liners, except on curves of six degrees or sharper where the distance should be reduced to whatever is necessary to give a clear view of the kinks.

The Farther Back the Better

By L. M. RODERK

Section Foreman, Minneapolis, St. Paul & Sault Ste. Marie, Medina Junction, Wis.

When lining long swings out of tangents I find that the farther back I get from the lining gang, the better line I can get. This requires that the work of the lining gang be guided by signals. By doing this, one has the opportunity to sight along the straight track for a sufficient distance to enable him to bring the swing into line with the least effort on his part and that of the gang. To finish, one should stand from 150 to 200 ft. back at which distance the small irregularities can be detected more easily, while it is far enough to avoid the probability of throwing small reverse swings in the rail.

For curves, I stand outside of the outer rail and far enough from the lining gang to obtain the correct angle of vision. In other words, the proper point of view is approximately from a line tangent to the curve at the point that is being lined. I usually try to work about 150 to 200 ft. away from the gang, since, if I stand closer I must get closer to the rail to obtain the proper angle of vision. For sharp curves, however, it becomes necessary to shorten this distance.

Advocates Use of Sighting Blocks

By R. ROSSI

R. Rossi & Son Industrial Track Construction Company

My experience is that 10 rail lengths is about the proper distance for a foreman to stand from the lining gang when taking out long swings. For this purpose I have found it advantageous to use three wooden blocks about 2½ in. by 6 in. by 4 in., one placed on the rail, edgewise to the line of sight, at each end of the swing, while the third is placed at each point of throw by the lining gang as it moves back and forth. The foreman stands from 60 to 90 ft. back of his block and brings the middle block into line with those at the ends, repeating the process until the track is thrown substantially to the final line. Minor corrections to give the finished line are then best made at distances ranging from 150 to 180 ft.

Before lining, a curve should always be surfaced and put to a uniform elevation. The distance at which one should stand will vary from about 275 ft. on a 1 deg. curve to 120 ft. on a 20 deg. curve. Curves should always be lined in and not out, except to iron out small irregularities. There is always a marked tendency to line a curve out, but this should be avoided in the interest of smooth-riding track.

Foremen Often Stand Too Near

By W. E. TILLETT

Assistant Foreman, Chesapeake & Ohio, Maysville, Ky.

Lining track requires clear vision. The large rail in common use today puts a strain on ones eyes during the process of lining that was unknown with the lighter sections. One reason for this is that the reflection from the wide running surface tends to blur the sharp definition of the gage side of the head. For this reason, many foreman are inclined to stand too close to the lining gang and, therefore, experience undue difficulty in getting a good finished line when taking out long swings. To do the work with the least effort and in a minimum of time, a foreman should stand from 500 to 1,000 ft. from the lining gang until the track is roughly to the final line. This may require going over the work two or three times if the total throw is large.

When ready to do the finished lining, a foreman should move in to from 100 to 250 ft., being very careful always to place the bars at the center of each kink or swing. If a considerable correction is necessary it is sometimes advantageous to place a series of small pebbles at the center of the rail head to assist in bringing it into line.

As contrasted with tangents, the view on a curve is severely limited, being shortened as the curvature increases. For this reason, the foreman stands near the high rail, and should watch both the high and low rail in order to get a better idea of what lining is necessary.

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Replacing Roofing Tile

What is the most satisfactory method for replacing broken tile in a tile roof ?

Should Be Done Only by Skilled Workmen

By L. L. TALLYN

Division Engineer, Delaware, Lackawanna & Western, Hoboken, N. J.

Before the question of maintenance comes up for discussion, consideration should be given to the advisability of placing tile roofs on structures of other than the better and more permanent types. There is grave doubt about the economy of doing so, while the fact must be taken into account that railway structures of every kind and type are being changed continually, or are torn down and replaced with others that are larger or more suitable. Consideration should also be given to the advisability of applying tile roofs to buildings that are exposed to extremely high winds or driving snow storms for snow working under the tile tends to lift and, often, break them.

Tile should be placed in the first instance and repaired only by men skilled in this type of work. When properly applied, the tile is nailed loosely so that it can be moved laterally or raised slightly to permit the removal of broken units and the insertion of new ones. The two tiles immediately above a broken tile are raised so that

any part of the broken tile that remains can be removed very easily, and also to permit the removal of the old nails. A copper strip from ½ to ⅝ in. wide, made from reasonably stiff sheet copper, and long enough to extend from ½ to 1½ in. past the new tile, is then nailed to the roofing boards or nailing strip. The new tile is put in place and the copper strip is bent up over the bottom edge of the tile to hold it in place.

Bonding With Plastic Cement Recommended

By FRANK R. JUDD

Engineer of Buildings, Illinois Central, Chicago

First remove completely all pieces of the broken tile, and all nails, using a ripper for the latter purpose. Next clean up the area occupied by the broken tile. Nail to the roof immediately above the tile next below the broken unit, a strip of 18-oz. copper, 1½ in. wide and 8 in. long, allowing it to project below the lower edge of the unit that is to be applied in replacement. Apply the replacement unit, placing it into position by lifting the tiles immediately above sufficiently to allow the new tile to be inserted. As soon as it is in place, bend the copper clip up and over its lower edge to lock it in position. When this part of the operation is completed, lift the tile or tiles immediately above the new tile enough to allow the placing of a layer of plastic cement on the upper part of the new unit, lower them and complete the bond by pressing them into the layer of cement.

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Rotary Pumps

What are the relative advantages and disadvantages of rotary pumps? What is their efficiency as compared with other types? For what service is the rotary pump best adapted **?**

Efficiency Changes with Capacity

By E. M. GRIME

Engineer of Water Service, Northern Pacific, St. Paul, Minn.

It may be said that the rotary pump is about half way between the ram or positive-acting type and the centrifugal pump. In the ordinary design, use is made of two revolving pistons, so timed in their motions that a positive pressure is exerted to force the liquid forward in an almost continuous stream without the intervention of valves, as required in the ordinary ram pump. One of the chief disadvantages of this type of pump lies in the difficulty experienced in maintaining water-tight contact between the casing and the rotating pistons. For this reason it has not been used extensively in recent years in service where a considerable lift is required. It is favored in some locations, however, because it is adapted for a wide range of speeds without materially affecting the ratio between delivery and pressure capacity.

In pumps of small capacity, say up to 200 g. p. m., the efficiency may range around 50 per cent. With the larger equipment, where leakage will be only a small percentage of the output and where the head is low, efficiencies will run much higher.

In industry, rotary pumps have been used largely for handling heavy viscous solutions or liquids and thickened precipitates of various kinds, such as asphalt, varnish, molasses, heavy oils and some confectionary products. These thick fluids interfere with the operation of valves in the ordinary positive acting pumps, while in the rotary pump leakage between the moving parts and the casing becomes relatively unimportant. Probably one of the most favorable situations for the use of this type of pumps occurs in irrigation districts where a large volume of water is handled under a low head. One notable installation of this kind is at Beaumont, Tex., where the rotary pumping unit has shown an overall efficiency of 80 per cent.

In railway work, the rotary pump has been used to advantage for moderate pressure heads, where only a small floor space is available and a positive-acting type of pump is required by reason of the suction lift being beyond the limit for a centrifugal pump. In some cases, operating changes have so altered the demand for water that the large positive-acting pump formerly required is now unnecessary and a small rotary pump requiring far less power can be installed at a cost about equal to that of repairing the old pump.

Rotary Pumps Are of Ancient Origin

By C. R. KNOWLES

Superintendent Water Service, Illinois Central, Chicago

The rotary pump dates back to the Fifteenth century and has long been a favorite type among the experimenters of pump design. Theoretically, it is among the most efficient of pumps and its simplicity has a certain appeal, since it acts without suction or discharge valves. It will handle practically any liquid from benzine to molasses. The use of rotary pumps on railroads has been confined almost entirely to the handling of chemicals, oils and other liquids. So far as I know they are not generally used for the purpose of supplying water to locomotives.

One of the largest installations of rotary pumps with which I am familiar is at Connersville, Ind., where an installation was made a number of years ago for the purpose of pumping the city supply.

In a bulletin recently issued by a large manufacturer of rotary pumps, the sizes of the pumps of this type listed ranged from a capacity of 1⅓ gal. per minute with a ⅜-in. discharge line up to 225 gal. per minute with a 3-in. discharge line.

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Corrugated Rail

What causes corrugations on the running surface of rail? What can be done to prevent or correct it **?**

The Cause Has Not Been Determined

By G. A. PHILLIPS

Chief Engineer of Maintenance, Lehigh Valley, Bethlehem, Pa.

This question touches on a subject which is becoming of increasing importance; in fact, of almost acute importance. The road with which I am connected has been practically free from rail corrugation previous to the last two years, except on the low rail on sharp curves, where corrugations have been relatively common, possibly as a result of wheel slippage. Beginning about two years ago, however, corrugations began to develop on high speed tracks and at present practically all of our main line is afflicted in this manner. While there are some indications of the trouble on our slow speed tracks, it has not yet developed to an acute stage. Strangely enough, sharp curves are now practically free from it.

What investigations we have made indicate that some other roads are having the same trouble, although I am not informed as to how extensive it is. We are making an exhaustive study to determine the cause, but as yet have made no progress although we have developed some

theories. We are also taking active steps to correct the rail conditions which we believe we are in a position to do at a nominal cost.

To my mind there can be but one cause for the corrugations; they must result from some form of vibration. So far, we have been unable to find the origin of this vibratory motion and how it is applied to the rails. Probably the most puzzling feature is that the trouble has developed so acutely and so extensively in the short period of two years.

I am not now in position to answer either of the questions more directly or more definitely. At present, we know neither the cause nor the remedy. We have some ideas with respect to the possibility of correction which we hope we will be able shortly to translate into constructive action, but until that time I do not believe any benefit will be derived from presenting them. I might add that while I regret my inability to answer the questions, since they are of such importance, I have discussed this matter with a number of maintenance officers of other roads and they seem to be in the same position in this respect that I am.

Question Is Especially Timely but Puzzling

By C. B. BRONSON

Assistant Inspecting Engineer, New York Central, New York

This question of corrugations on rail heads is especially timely, in view of the fact that this trouble is increasing and spreading. At least, that is my general observation as I look back several years and recall the experience on our own lines. It is an equally puzzling question when one attempts to give an answer.

We find that corrugations are occurring in two general groups or locations. The first is in the vicinity of stations or other stopping points where retardation from the brakes is sudden. Chattering occurs, apparently, as a result of slight slips of the wheels. I understand that this is quite noticeable in subway and street-car service. The second group, which is far more extensive, is out in the open where train speeds are high. Any conclusions which we have reached so far with respect to this group are tentative. In fact, they are more or less conjecture. The one clue we have is from the speed tapes in the locomotives, which indicate that as train speeds reach or pass 75 miles an hour, the peripheral speed of the drivers may approach or exceed 100 miles an hour. This undoubtedly results in an irregular slip of these wheels on the rails, probably tending to dig into the surface in some places and possibly piling up a little metal just ahead of these low spots. This action is probably somewhat similar to that which causes the corrugations that are so prevalent on gravel roads, particularly where highway vehicles operate over them at high speeds.

This condition has become more widespread since the introduction of the newer types of power, and also with the step-up in operating speeds. How much each of these has tended to increase the corrugations in either number or amount is, at present, merely a guess.

Many have believed that corrugations are associated with certain brands of rails, with certain rollings, or with certain compositions of steel. In my judgment, these factors have virtually nothing to do with the matter. While this statement may be disputed, we know for a fact that on fast track and around many stations they occur in rails of every brand, of various compositions and of different rollings in many places all over the New York Central system.

We have made numerous observations and studies of the characteristics of corrugations. In general, the bright spots range from one to four inches apart. They occur towards the gage side or away from it, depending on the inclination of the rail. The spots may be ½ to 1½ in. long, feathering off into the dull metal that lies between the bright spots. The width, measured across the head, may be as low as ¼ in. or it may be more than ¾ in. While, to the eye in the sunlight, the ripples appear to be pronounced, and although they cause considerable of a roar when a train passes over them, the depth is quite shallow. They are generally from 0.004 to 0.006 in. deep and rarely exceed 0.01 in. in depth. A close check indicates that they do not increase appreciably in depth after several years.

They develop rapidly in some locations, that is within three to five years after the rail is in service. This has been particularly noticeable since the era of changed operating conditions and power which have been mentioned. Undoubtedly, in my judgment, corrugations could be reduced materially or eliminated if we did not have to contend with the operating conditions mentioned in the second paragraph of this discussion. We cannot expect much relief from this direction, however.

Changes in rail design, type of material or heat treatment so far have not offered any prospect of correcting the condition. Some good may be accomplished by grinding down the local high spots on the corrugated rail heads and it is likely that several roads will experiment along these lines. But there may be no assurance that the condition, once corrected, will not recur.

While the foregoing information may seem not to be specific, the problem under consideration is apparently going to be difficult of solution, especially as there is so little to take hold of. We are giving the matter much thought and intensive study, and we hope eventually to eliminate the trouble or at least to improve conditions materially.

Finds Cause Difficult to Determine

By ROBERT FARIES

Assistant Chief Engineer-Maintenance, Pennsylvania, Philadelphia, Pa.

We find the cause of corrugations in rails to be a matter difficult of determination. We have corrugated rail in long stretches on tangents and on the low rails of curves. It has been my observation that the condition is more noticeable for 20 or 30 miles after leaving large yards than it is generally on other sections of the road, indicating that there is some action of the trucks that distorts minute portions of the metal and pushes them up in ridges about 2 in. to 2½ in. apart. Once started, both the amplitude of the corrugations and the length of track affected probably increase.

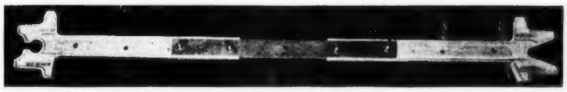
I believe that the cause will be found in the eccentric movement of the trucks, probably of freight cars, which causes their adjustment to the track to take place in a series of slight jumps rather than in a regular rolling of the truck. It will readily be seen that this might take place on curves where adjustment has to occur because of the difference in the distance that the wheels travel around the inner and outer rails. Where the corrugations take place on tangent, it may be the result of an eccentric action of the truck caused by brakes sticking, a slight difference in the circumference of the wheels or some similar irregularity.

As to the remedy, these corrugations can be removed by grinding with a reciprocal grinder or by dragging weighted abrasive bricks over the rail, moving them back and forth a number of times. So far as our experiments have gone, however, the present cost of doing this indicates that it is better to remove the rail and put it in some slow-speed track where the corrugations are not so objectionable.

New and Improved Devices

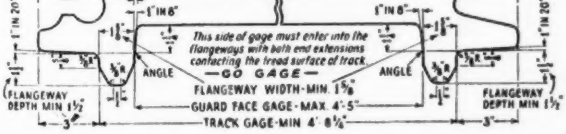
New Frog and Crossing Limit Gage

THE Ramapo Ajax Corporation, New York, is now furnishing to the railways a frog and crossing limit gage, manufactured to conform with the design for such a gage adopted by the American Railway Engineering Association at its last convention. The new gage, which meets all of the newly adopted recommendations of the association relating to gages and flangeways through frogs and crossings, is the first tool of its kind available and is already being accepted with considerable favor. As furnished, the gage consists of two end castings, of either aluminum or steel, joined together by two mahogany strips and held rigidly as a unit by four turned bolts with wing nuts. Thus, the gage can be dismantled, if desired, to make it more convenient to carry about on a train or motor car. Uneven alinement of the bolt holes prevents the wrong assembly of the parts. In both types of construction, that is, aluminum or steel, the gage is sturdy, being made in I-beam section, and, in either case, is relatively light, the aluminum model weighing only about 8 lb., while the steel model weighs approximately 14 lb.



The New Limit Gage in Aluminum—Weighs Eight Pounds

With the limit gage, it is possible to check the flangeway width and depth, the guard face and guard check gages, and the track gage. All of these dimensions, with the exception of the guard check gage, are made with the "go gage" side down, the guard check gage test being made by turning the gage over and using its "no go" side. To preclude any possible confusion, the different sides of the gage are plainly marked.



A.R.E.A. Plan for Frog and Crossing Limit Gage to Which New Gage Has Been Constructed

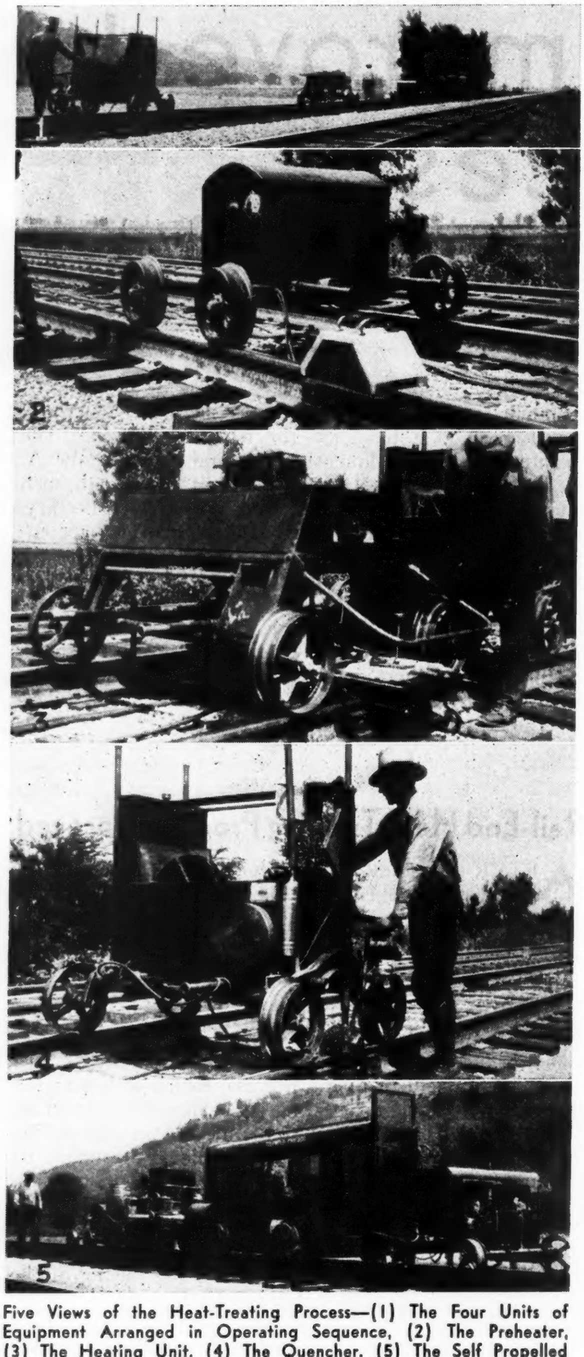
The importance of maintaining the proper dimensions or clearances through frogs and crossings is appreciated the more when it is realized that incorrect dimensions, as a result of either faulty construction or the flow of metal in service, invariably cause either track or wheel distortion, and a tendency for wheels to climb. The maintenance of the dimensions recommended by the A. R. E. A. through the use of the limit gage, with such alinement readjustment or grinding as may be necessary, will eliminate these destructive conditions, which are enlarged in the case of the newer heavy-rail rigid trackwork now being used. With specific reference to distortion in frogs and crossings as a result of improper dimensions, the Committee on Track, in its report for 1933, pointed out that the elimination of the distortion through the use of the dimensions recommended would add to the life of the trackwork fixtures and should result in a considerable saving in maintenance costs.

Rail-End Heat-Treating Process Improved

AFTER several months of intensive service tests of its process for the heat-treatment of rail ends, the Electric Railweld Sales Corporation is now applying the process on a commercial basis. Of special interest in this connection are the changes in practice, involving a number of improvements in the equipment, that have been made since the Teleweld process for heat-treating rail ends was described in *Railway Engineering and Maintenance* for December, 1932.

The improvement in the process, which embraces the preheating, electric-arc heating, quenching and tempering of the rail in four distinct steps, include an appreciable shortening of the time required, better synchronizing of the operations of the different steps of the process, refinements in the individual units of equipment and the substitution of an entirely new type of equipment for the preheating.

The preheating has for its purpose, the raising of the temperature of the rail to 600 deg. F., both to reduce the temperature gradient in the subsequent arc-heating process and to eliminate the variations that would result from an attempt to apply the process under varying initial temperatures. In the original process this operation was performed with a gasoline furnace, but it is now done with an induction device in which the rail head is placed in the magnetic field of a transformer carrying a high frequency (500-cycle) alternating current, with the result that the high frequency eddy currents generate sufficient heat to raise the temperature of the rail at a very rapid rate. The current for this operation is supplied by an a. c. generator in the same car-mounted power plant which supplies low voltage direct current for the operation of the arc heater. The current input is measured accurately on a watt-hour meter, the exact current consumption being varied with atmospheric temperatures or the initial temperatures of the rail.



Five Views of the Heat-Treating Process—(1) The Four Units of Equipment Arranged in Operating Sequence, (2) The Preheater, (3) The Heating Unit, (4) The Quencher, (5) The Self Propelled Generator and Other Equipment Coupled Up for Moving

The main arc heater is substantially as described in the article referred to above, embodying the use of a train of gears and a system of cams driven by a motor for the purpose of causing the arc to move rapidly over the rail surface to be heated, in accordance with a pattern that insures uniform heating over the entire area. As now developed, this process has been modified by magnetic means to spread the arc stream into the form of a brush about an inch wide, in this way producing a relatively soft flame that permits of the use of a heavier current without danger of burning the rail and also speeds up the process so that the desired temperature of 1,600 deg. F. is attained in about two min., whereas three min. was formerly required. Water cooling of the electrode holder has also been introduced to keep down the temperature to workable limits.

No substantial changes have been made in the quencher which comprises apparatus for the application of circulated oil to the head of the rail at a fixed temperature and for a predetermined period. The same observation applies with respect to the self-tempering which consists in allowing the rail to cool from the final quenching temperature to atmospheric temperature by exposure to the air, except that in cold weather or during heavy winds, asbestos blankets are placed over the rails for short periods.

In general, the key to the process as worked out is the provision for substantially automatic control to eliminate personal equation as far as possible, plus a co-ordination of the operations so that each unit moves forward from one joint to the next after the same interval of time, and under normal operating performance an average of 20 joints are heat-treated per hour. The power plant which supplies current to the three primary operations is self-propelled and is used for hauling the equipment. All the car units can be set off the track, but for greater safety the work is handled under flag protection. The outfit requires five men and a foreman in addition to a pilot furnished by the railroad. During the past few months this plant has been employed to heat-treat the rail ends on 12 miles of track including two-mile stretches on the Union Pacific, the Boston & Maine, the Chesapeake & Ohio, the Erie, the Missouri Pacific and the Pere Marquette, since which time it has returned to the Union Pacific where it has completed 16 miles of additional track and is now engaged on 15 miles more on the Boston & Maine. Arrangements have also been completed for the treating of several test sections on the New York Central.

New Books

History of Civil Engineering

EARLY DAYS OF MODERN CIVIL ENGINEERING, by Richard S. Kirby and Philip G. Laurson. 324 pages, illustrated, 6 in. 9 in. Bound in cloth. Published by Yale University Press, New Haven, Conn. Price $4.

To cover such a large subject in the space of 324 pages calls for a great deal of condensation, with the result that the treatment of individual branches of civil engineering, such as railway engineering and bridge engineering is much more abridged than in other texts devoted entirely to any one of them alone. However, the book is exceptionally readable, the authors used discrimination in the selection of the material and the initial chapter on surveying contains much that is new to most civil engineers. In addition to chapters on the various branches of civil engineering, there is a chapter on Materials, followed by a chapter of biographical outlines of the leading civil engineers of history. The book contains a large number of attractive illustrations, including portraits of 24 famous engineers of the eighteenth and nineteenth century.

On the Grand Trunk Western

News of the Month . . .

L. & N. Asks Permission to Continue Two-Cent Fare Experiment

Finding that an experimental period of six months is not sufficient to demonstrate whether a railroad passenger rate of two cents a mile has advantages as compared with the standard fare, the Louisville & Nashville has applied to the Interstate Commerce Commission for permission to continue the lower rate another six months. It is hoped, however, that the reduced rate will eventually accomplish the desired purpose as the downward trend of passenger revenue has been modified.

Fewer Loans From R. F. C. Asked By Railroads

Since the improvement in railway traffic and earnings began late this spring, there has been a marked slowing up in applications for loans from railroads to the Reconstruction Finance Corporation and the Interstate Commerce Commission. The corporation reports that as of the close of business on August 29 loans to railroads totalling $411,701,426 had been authorized since the corporation began operation on February 2, 1932, of which $381,321,802 had been advanced and $50,184,353 had been repaid.

Chicago Labor Day Traffic Heaviest In Years

The largest passenger traffic movement in the middle west in recent years was handled on September 2, 3 and 4, when an estimated 100,000 persons were carried into Chicago by railroads as a result of the low rate in effect for A Century of Progress Exposition. The Pennsylvania alone carried a total of 21,900 persons into Chicago and approximately the same number out, this movement necessitating the operation of 110 extra trains. The New York Central Lines brought 20,671 passengers into Chicago on the three days, this movement involving the operation of 81 extra sections. The number of passengers handled by other roads were approximately as follows: Chicago, Burlington & Quincy, 8,000; Atchison, Topeka & Santa Fe, 6,000; and Baltimore & Ohio, 2,000.

Railway Employment Increases in August

The number of employees on the Class I railroads of the country totaled 1,014,879 as of the middle of August which was an increase of 25,749 as compared with July and of 34,252 as compared with August, 1932. August was the first month since October, 1932, that the number of employees reached the million mark. As compared with the month of March this year when railroad employment reached its lowest level, the number of employees in August represented an increase of 94,998. Maintenance of way and structure employees in August totaled 219,322, this being an increase of 2.16 per cent as compared with August, 1932.

Injuries to Toes Predominate on Canadian National

Injuries to toes predominate over all other types of injury among employees engaged in track laying and maintenance of way, according to data compiled by the Safety Council of the Canadian National Railways. Because of such injuries 344 employees on the C. N. R. lost 7,152 working days during the past year, this representing a monetary loss of about $25,000. The objects dropped on toes ranged up to 800 lb. in weight. As a precaution against such accidents the Safety Council recommends the use of a safety boot with a steel protected toe cap. During tests, this type of boot has prevented injuries to toes even when an iron tire weighing 690 lb. was dropped on a workman's foot.

Freight Traffic in July 38.8 Per Cent Over Last Year

The volume of freight traffic handled by the Class I railroads in July, measured in net ton-miles, showed an increase of 38.8 per cent above that of the same month in 1932, according to reports compiled by the Bureau of Railway Economics. It amounted to 26,459,634,000 net ton-miles, as against 19,065,342,000 net ton-miles in July, 1932. Compared with the same month in 1931, however, freight traffic in July this year showed a reduction of 3,815,947,000 net ton-miles or 12.6 per cent. Freight traffic in the first seven months of 1933 amounted to 150,189,406,000 net ton-miles, an increase of 3,162,529,000 net ton-miles, or 2.2 per cent, over that of the corresponding period in 1932, and a reduction of 54,430,086,000 net ton-miles, or 26.6 per cent, under that of the corresponding period in 1931.

Suggests Transforming Branch Lines Into Highways

A suggestion that America's network of branch line railroads be transformed into motor highways for commercial and military efficiency of the nation's transportation system was suggested by Lieutenant-Colonel Brainerd Taylor of the quartermaster corps, U. S. A., in an address recently at Chicago. "Modern highways," he said, "should replace or supplement branch line railways where operation of such lines is obsolescent practice. In many cases, the transformation of trunk lines, which no longer earn their operating and maintenance expenses, into new highways for fast freight and passenger service, truck and bus, is suggested. The old railroad beds are wonderfully ballasted and ready for smooth road surfacing. They connect all the important towns and villages with more important terminals and trunk line railroads. However, motor transport highways should never be constructed and used to replace or injure our trunk line roads.

Railroad Net in July Six Times July, 1932

For July the Class I railroads of the United States had a net railway operating income of $64,309,929, which was nearly six times the net of $11,287,720 which they had in the corresponding month of 1932. Operating revenues for July amounted to $293,714,774, as compared with $235,332,794 in July, 1932, an increase of 24.8 per cent. For the first seven months of 1933, these railroads had a net of $216,740,345, as compared with a net of $120,900,560 in the corresponding period of 1932. In the seven months' period of this year, operating revenues totaled $1,708,940,892, a decrease of $109,762,641, or 6 per cent as compared with the same period in 1932.

Asks Railroads to Co-operate in Reducing Unemployment

Suggestions as to methods by which railroads and their employees may co-operate to carry out the principle of the national industrial recovery act, despite the fact that the act does not apply directly to the railroads, have been laid before all railroad presidents and the executives of railroad labor organizations by Joseph B. Eastman, federal co-ordinator of transportation. Railroads are urged to use every available dollar, as traffic and revenue increase, to put more men to work and to invite the employees, through their representatives, to confer with the managements as soon as possible for the purpose of arriving at voluntary mutual agreements to spread available work by curtailing overtime, reduce the length of the work day to at least eight hours, discontinue the practice of making seven days a week, where it still exists, and to reduce the mileage of train service employees to mutually acceptable levels.

Railway Officers' Salaries Limited to $60,000 Yearly

The railroads of the United States have agreed to limit the salaries of their chief executives to a maximum of $60,000 a year, according to a statement issued recently by Joseph B. Eastman, federal co-ordinator of transportation. The application of this maximum follows reductions already made of about 40 per cent in executives' salaries during the last five years, and Mr. Eastman expects that corresponding adjustments will be made in the salaries of lesser officers. In his statement Mr. Eastman expressed the opinion that $50,000 plus the "joy of creative work well done," a "sense of power," and "public recognition of emi-

nence," should be sufficient compensation for any railway executive under present conditions, although he is reluctant to issue an order on the subject both because the amounts involved are "relatively insignificant" and because to do so would be to go too far in the duties of railroad management to be consistent with the fact that the railroads, though subject to regulation and co-ordination, are still private enterprises.

Carloadings Hold Gain

Weekly carloadings of freight in the United States have now been greater than the corresponding weeks in 1932 for 20 consecutive weeks and while the weekly margins of increase are somewhat smaller than during July and August they are still substantial. Loadings of revenue freight during the week ending September 23, which is the latest week for which figures are available, totaled 652 669 cars, which was an increase of 653 cars above the preceding weeks, and a gain of 57,065 cars above the corresponding week in 1932. It was a decrease, however, of 85,367 cars below the same week in 1931.

Additional Allotment for Upper Mississippi River

An additional allotment of $22,000,000 for the construction of locks and dams on the upper Mississippi river, where the need of employment is said to be pressing, has been announced by Federal Administrator of Public Works, Harold L. Ickes. This allotment is in addition to an authorization of $11,500,000 previously made by the administration for the dredging of a nine-foot channel on the upper Mississippi between St. Louis and Minneapolis as part of a comprehensive program of river improvement. The total cost of the upper Mississippi River project is estimated at $124,000,000.

Predict Increase of 15 Per Cent in Last Quarter Carloadings

Freight carloadings in the United States in the fourth quarter of 1933 will be nearly 15 per cent above actual loadings in the same quarter of 1932, according to figures compiled by the thirteen shippers' regional advisory boards. On the basis of these estimates, freight carloadings of the 29 principal commodities, which constitute over 90 per cent of the total carload traffic, will be 4,920,000 cars in the fourth quarter of 1933, compared with actual loadings of 4,290,000 cars in the same period of 1932. Every one of the advisory boards, which include about 20,000 shippers throughout the United States, reported an increase in the estimated carloadings for the fourth quarter of this year as compared with the same period last year. The largest percentage increase is expected to take place in the Great Lakes region where it is anticipated that carloadings will increase 36.5 per cent over last year. Increases of 31 and 31.5 per cent, respectively, are expected to take place in the Northwest and Allegheny regions, while the smallest anticipated increase is that of 0.7 per cent in the Trans-Missouri-Kansas region. Of the 29 commodities carried in the forecast, it is anticipated that 23 will show an increase.

Railroad Purchases Increase to 39 Millions in July

Continued expansion in railway purchases is revealed by statistics of expenditures made by the railroads for materials and supplies during the month of July. According to reports from 46 railroad systems earning over 60 per cent of gross railway operating revenue, the Class I railroads of the United States spent approximately $39,000,000 for fuel and supplies in that month, which was approximately $6,000,000 higher than in January and about $10,000,000 higher than in April. Purchases in July were greater than for any month since July, 1932. They included approximately $14,500,000 for fuel, $2,700,000 for crossties and about $21,800,000 for miscellaneous materials, including rail and repair parts for locomotives and cars.

Eastman Asks Survey of Freight Car Equipment

Stating that complete information is necessary "if a comprehensive program is to be adopted for the general retirement and rehabilitation of freight equipment, and adequate plans made for the purchase or construction of new freight cars," Joseph B. Eastman, federal co-ordinator of transportation, has sent a questionnaire to the executives of Class I railroads requesting them to make a thorough canvass of existing freight car equipment and to submit at the earliest practical date their views as to the repair or retirement of worn-out and obsolete cars. The co-ordinator points out that notwithstanding many thousands of freight cars have been retired during the past three years, there are still many whose period of service has expired but which still occupy yard and storage tracks, constituting a burden upon transportation and creating unnecessary hazards. In anticipation of a continued increase in traffic, it is desirable that this unproductive equipment be dismantled, he says.

Eastman Investigates Truck Transportation

Stating that an important duty which he has under the emergency transportation act is the investigation of the relation of motor trucking to freight transportation, "the primary purpose of which will be to determine the sphere in which the transportation of goods by motor vehicles is more economical or serviceable than by other means of transportation," Joseph B. Eastman, federal co-ordinator of transportation, has sent a questionnaire to about 1,000 operators of motor truck fleets calling for voluminous basic data relating to truck operations. Information requested includes the character and extent of the traffic handled, the charges of trucks operated for hire, the nature of the service performed, and expense statistics of motor truck operation.

Association News

Roadmasters Association

It is planned to hold a meeting of the executive committee late in October to select new subjects for investigation during the year and to appoint committees to prepare reports on these subjects, looking to a convention in September, 1934.

Wood-Preservers' Association

Members of the executive committee will meet at the Union League Club, Chicago, on October 11, to complete plans for the thirtieth annual convention which will be held in Houston, Tex., on January 23-25, 1934, and to transact other business coming before the association.

Metropolitan Track Supervisors' Club

The first fall meeting of the Metropolitan Track Supervisors' Club will be held on Thursday, October 26, at the usual place of meeting, Keen's Chop House, 72 West Thirty-sixth street, New York City. The business session will follow the dinner which will be served at 6:30 p. m. The principal speaker will be R. W. Brown, vice-president and general manager of the Central of New Jersey, who will discuss an unannounced subject.

American Railway Engineering Association

Special assignments have been given to two committees recently, which are in addition to those in the published list of subjects. The Committee on Track has been requested to prepare plans and specifications for tie plates, and the Rail committee has been asked to design joint fastenings for the 131-lb. and 112-lb. rail sections that were adopted recently.

The Sixth progress report of the Committee on Stresses in Track is now on the press and will be ready for mailing early in October. So far, this is the only committee report that has been turned in for the current year, but several committees expect to complete their reports shortly.

October meetings have already been scheduled for six committees and others expect to hold meetings this month but have not yet set definite dates. Those now scheduled are Ballast, October 5; Standardization, October 6; Rail, October 7; Wood Preservation, October 10; Wooden Bridges and Trestles, October 13; Rivers and Harbors, October 24. All will meet at Chicago, except the Committee on Ballast which will hold its meeting at Pittsburgh, Pa.

In addition, the General committee of the Engineering division will meet on October 6 at Chicago, on which day R. M. Lockwood, director of the Section of Purchases, on the staff of Federal Co-ordinator Eastman, and his assistant, George A. Cooper, will address this committee and that on Standardization.

Personal Mention

General

W. W. Patchell, division engineer of the Philadelphia Terminal division of the Pennsylvania, at Philadelphia, Pa., has been promoted to superintendent of passenger transportation on the Central region, with headquarters at Pittsburgh, Pa.

Engineering

M. McKimmey, resident engineer of the Missouri & North Arkansas, has been appointed to the newly-created position of chief engineer, with headquarters as before at Harrison, Ark.

J. W. Pfau, who has been acting chief engineer of the New York Central, Lines Buffalo and East, since **F. B. Freeman** was furloughed because of ill health in June, has been appointed chief engineer, with headquarters at New York. Mr.

J. W. Pfau

Pfau was born on September 18, 1876, at Troy, N. Y., and was educated at Rensselaer Polytechnic Institute at Troy, from which he graduated in 1899. In the same year he entered railway service as a chainman on the New York Central & Hudson River (now the New York Central) and after serving in various capacities in the engineering department he left this company in 1904 to enter the service of the State of New York as a masonry expert. Two years later he re-entered the engineering department of the New York Central as a resident engineer at New York, which position he held until 1908 when he was made engineer of grade crossing elimination with the same headquarters. From 1910 to 1927 he held the position of engineer of construction, and in the latter year he was promoted to assistant chief engineer, which position he held until his appointment as acting chief engineer in June.

J. P. Ensign, assistant supervisor of track on the New York Central, with headquarters at New York has been appointed assistant division engineer on the Eastern division, at New York, succeeding **H. A. Fredrickson,** whose promotion to supervisor of track is noted elsewhere in these columns. Mr. Ensign, who was born on June 7, 1898, at Easton, N. Y., was graduated from Union College and started his railway career as a draftsman with the New York Central at New York on May 15, 1923. On September 1, 1925, he was promoted to an inspector in the track department, and on September 1, 1926, he was promoted to assistant supervisor of track, which position he was holding at the time of his recent appointment as assistant division engineer.

C. O. Long, assistant division engineer of the Middle division of the Pennsylvania, with headquarters at Altoona, Pa., has been promoted to division engineer of the Logansport division, at Logansport, Ind., to succeed **W. D. Supplee,** who has been transferred to the Buffalo division, at Buffalo, N. Y. Mr. Supplee replaces **D. Davis, Jr.,** who has been transferred to the St. Louis division, with headquarters at Terre Haute, Ind., to succeed **N. M. Lawrence,** who goes in the same capacity to the Philadelphia Terminal division, at Philadelphia, Pa., to relieve **W. W. Patchell,** who has been promoted to superintendent of passenger transportation at Pittsburgh, Pa., as noted elsewhere in these columns. **P. X. Geary,** track supervisor on the New York division at New York, has been promoted to assistant division engineer of the Ft. Wayne division at Ft. Wayne, Ind., to succeed **F. G. Church,** who has been transferred to the Middle division at Altoona, where he replaces Mr. Long.

Track

C. L. Stuckey has been appointed roadmaster on the Gulf Coast Lines, with headquarters at San Benito, Tex., to succeed **A. R. Craddock,** deceased.

G. W. Hammonds has been appointed a roadmaster on the Gulf Coast Lines, with headquarters at Kinder, La., to succeed **J. G. Maynor,** who has been assigned to other duties.

C. Hewitt, general foreman on the Lehigh Valley, with headquarters at Sayre, Pa., has been appointed supervisor of track, with headquarters at Aurbin, N. Y., succeeding **J. E. Pierce,** who died on July 23.

A. G. Greenough, assistant track supervisor on the Philadelphia division of the Pennsylvania, has been promoted to track supervisor on the Cincinnati division with headquarters at Anderson, Ind., to succeed **J. S. Snyder,** who has been transferred to Middletown, Ohio, to replace **J. J. Glutz,** who has been transferred to New York.

H. A. Fredrickson, assistant division engineer on the Eastern division of the New York Central, with headquarters at New York, has been appointed supervisor of track, with headquarters at Pawling, N. Y., succeeding **R. M. Mahar** who died on August 8, as noted in the September issue. **George Johansen** has been appointed assistant supervisor of track on the electric division, with headquarters at New York, succeeding **J. P. Ensign,** who has been appointed assistant division engineer, as noted elsewhere in these columns.

Mr. Fredrickson, who was born on March 11, 1891, at Cornwall-on-Hudson, N. Y., was graduated from Ohio Northern University with a degree in civil engineering. He started his railway career with the New York Central as a chainman at Watertown, N. Y., on September 18, 1913. On April 20 of the following year he was promoted to rodman, with the same headquarters, and on December 6, 1915, he became a draftsman in the engineering department at New York. On March 1, 1916, he was appointed transitman at New York, and on April 16, 1917, he was promoted to assistant supervisor of track at Hudson, N. Y. He became assistant division engineer at New York on June 16, 1918, and held this position until his recent promotion to supervisor of track.

A. O. Wiedenthal, a track foreman on the Michigan Central, has been promoted to roadmaster with headquarters at Lansing, Mich., to succeed **W. Miller,** who has retired. **F. R. Miller,** roadmaster at Jackson, Mich., has been transferred to Kalamazoo, Mich., to succeed **W. Peterson,** who has been transferred to Battle Creek, Mich.

W. J. Deyette, a track foreman on the Canadian National, with headquarters at Gamebridge, Ont., has been promoted to roadmaster on the Hornepayne division, with headquarters at Nipigon, Ont., to succeed **H. Jacklin,** who has been transferred to the Capreol division with headquarters at Capreol, Ont., where he replaces **W. E. Trites,** deceased.

Bridge and Building

L. G. Byrd, bridge and building supervisor on the Missouri Pacific, with headquarters at Wayne, Ark., has had his headquarters moved to Poplar Bluff, Mo., where he will have jurisdiction over 400 miles of new territory in addition to his former territory.

Special

H. B. Trace, has been appointed welding supervisor of the Erie, with headquarters at Cleveland, Ohio, to succeed **R. L. Butterfield,** who has been assigned to other duties.

Obituary

John H. Hall, formerly a roadmaster on the Missouri Pacific, and more recently head of a railroad contracting firm, died at Little Rock, Ark., on September 13, at the age of 71 years.

William H. Tichbourne, who retired in 1929 as bridge and building master on the Canadian National, with headquarters at London, Ont., died on August 8, at the age of 74 years, following an illness of about six months.

Supply Trade News

Personal

Arthur W. Armstrong has been elected president of the **Wood Preserving Corporation,** the **Century Wood Preserving Company,** the **National Lumber & Creosoting Company,** and the **Carolina Wood Preserving Company,** with headquarters at Pittsburgh, Pa., succeeding **Grant B. Shipley,** who has resigned as president and who has been elected chairman of the board of directors of the Wood Preserving Corporation, Mr. Shipley having asked that he be relieved of the active management of these companies in order that he might devote time to his personal interests. Prior to his appointment, Mr. Armstrong was president and general manager of the Ayer & Lord Tie Company, Pittsburgh, and executive vice-president of the Wood Preserving Corporation, the National Lumber & Creosoting Company, and the Century Wood Preserving Company.

Mr. Armstrong was born in Evanston, Ill., on April 9, 1885, and graduated from Northwestern University in 1907. In 1903 he worked in the freight department of the Chicago & North Western, and in 1904 he entered the employ of the Ayer & Lord Tie Company in the general offices, returning to school in 1905. Two years later, following his graduation, he

Arthur W. Armstrong

was appointed superintendent of the Ayer & Lord treating plant at Grenada, Miss., and until 1915 occupied various positions in the operating department of this company. In that year he was appointed secretary and treasurer, which position he held until 1925, when he was appointed general manager. In 1927, he was elected president and general manager and in 1932, following the formation of the Wood Preserving Corporation to consolidate the 22 timber treating plants of the Ayer & Lord Tie Company, the National Lumber & Creosoting Company and the Century Wood Preserving Company, he was made executive vice-president of all these companies, with the exception of the Ayer & Lord Tie Company, of which he remained president and general manager at present he is chairman of the special committee on the Processing of Wood of the Wood Preservers' Assn.

Mr. Shipley was born at Coulterville, Cal., on April 27, 1880. From 1898 to 1901 he was a machinist apprentice in a general repair shop and from the latter date until 1905 he was employed as a draftsman on marine equipment, mining machinery and gold and silver machinery and plants. During part of this period he was also an instructor of marine design and mechanical drawing. In 1905 he went with the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., and from 1911 to 1932 he was associated as an executive and operating officer with

Grant B. Shipley

various tie, coal and timber treating companies and has been a practicing, designing and consulting engineer for timber treating and other plants. After leaving the Allis-Chalmers Company, Mr. Shipley organized the Pittsburgh Wood Preserving Company and became its president, becoming in 1922 also associated with the American Nickel Corporation, which later became the American Mond Nickel Company with Mr. Shipley as president. When this company was absorbed by the International Nickel Company of Canada in 1929 he was elected a director and a member of the executive committee of the latter company. In 1923 he organized the Century Wood Preserving Company, and following the formation of the Wood Preserving Corporation in 1930 he was elected president of this company as well as of its operating units.

Obituary

Lloyd F. Layne, president of Layne & Bowler, Inc., Memphis, Tenn., pump manufacturers, died at Memphis on September 7, at the age of 41 years.

Trade Publications

Oxwelded Piping.—The Linde Air Products Company, New York, has published a 156-page booklet entitled Fabrication of Oxwelded Piping, the purpose of which is to provide the necessary data and procedure for the satisfactory use of oxy-acetylene welding and cutting in making pipe joints. The book is divided into four principal parts, the first of which, entitled Fabrication of Steel and Wrought Iron Piping gives complete and detailed instructions for doing this work. The three other parts are entitled: Templet Layout for Welded Fittings; Tables for Estimating Costs; and Welding of Cast Iron and Non-Ferrous Piping.

Armco Multi Plate—The Armco Culvert Manufacturers Associations, Middletown, Ohio, has issued an eight-page illustrated folder describing and illustrating some of the applications and advantages of Armco Multi Plate culvert pipe.

Splash and Drip-Proof Motors.—A four-page pamphlet describing and illustrating a new line of splash and drip-proof motors and controls has been issued by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.

Caterpillar Thirty-Five Tractor.—The Caterpillar Tractor Company, Peoria, Ill., is distributing a 38-page, attractively-illustrated booklet, which is devoted to a description of the various mechancial features of the Caterpillar 35 Tractor.

Caterpillar Diesel Engine.—The various advantageous features of the Diesel engine which was recently developed by the Caterpillar Tractor Company, Peoria, Ill., are set forth in a 20-page booklet that has been issued by this company. The book is attractively-illustrated.

Bars, Shapes and Plates.—The Inland Steel Company, Chicago, has just published a new booklet on bars, shapes, plates and semi-finished steel entitled, "Sizes We Roll and Standard Extras." It incorporates all recent changes in extras, and also includes tolerances and size data on the products of this company's bar, plate and structural mills.

Cast Iron Pipe.—A 56-page booklet has been issued by the Central Foundry Company, New York, featuring Universal and Dual-Lok Joint cast iron pipe, together with the various types of fittings used with these designs. The booklet lists the various sizes of pipe and fittings available and describes clearly the adaptability of the pipe to various services and the method of its installation.

Armco Metal Cribbing for Retaining Walls.—This is the title of a 24-page booklet that has been issued by the Armco Culvert Manufacturers' Association, Middletown, Ohio, which is devoted to an explanation of the uses and applications of Armco metal cribbing in the construction of retaining walls. This booklet is profusely illustrated and attractively printed.

Fumigation.—The R. & H. Chemical department of E. I. du Pont de Nemours & Company, Wilmington, Del., has issued an informative folder entitled "Fumigation of Industrial and Domestic Structures by Means of Cyanegg." The folder discusses briefly the fumigation of different types of structures, including railway buildings and equipment, and includes a dosage schedule for fumigations using Cyanegg under various circumstances and conditions.

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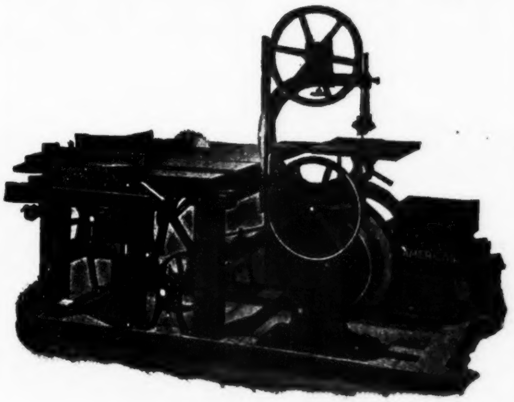

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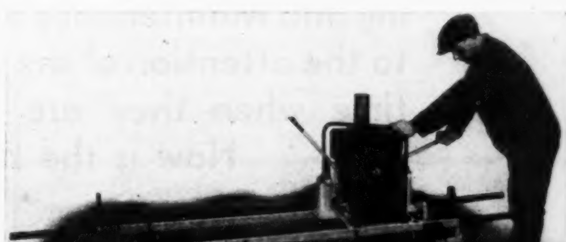

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